R&S®FSV-K10x (LTE Downlink)
LTE Downlink Measurement Application
User Manual

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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual describes the following firmware applications:

- R&S®FSV-K100 EUTRA / LTE FDD Downlink Measurement Application (1308.9006.02)
- R&S®FSV-K102 EUTRA / LTE MIMO Downlink Measurement Application (1309.9000.02)
- R&S®FSV-K104 EUTRA / LTE TDD Downlink Measurement Application (1309.9422.02)

This manual describes the following R&S®FSV models with firmware version 2.0 and higher:

- R&S®FSV 4 (1321.3008K04)
- R&S®FSV 7 (1321.3008K07)
- R&S®FSV 13 (1321.3008K13)
- R&S®FSV 30 (1321.3008K30)
- R&S®FSV 40 (1321.3008K39)
- R&S®FSV 40 (1321.3008K40)

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The following abbreviations are used throughout this manual: R&S®FSV is abbreviated as R&S FSV.

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1 Introduction

Currently, UMTS networks worldwide are being upgraded to high speed downlink packet access (HSDPA) in order to increase data rate and capacity for downlink packet data. In the next step, high speed uplink packet access (HSUPA) will boost uplink performance in UMTS networks. While HSDPA was introduced as a 3GPP Release 5 feature, HSUPA is an important feature of 3GPP Release 6. The combination of HSDPA and HSUPA is often referred to as HSPA.

However, even with the introduction of HSPA, the evolution of UMTS has not reached its end. HSPA+ will bring significant enhancements in 3GPP Release 7. The objective is to enhance the performance of HSPA-based radio networks in terms of spectrum efficiency, peak data rate and latency, and to exploit the full potential of WCDMAbased 5 MHz operation. Important features of HSPA+ are downlink multiple input multiple output (MIMO), higher order modulation for uplink and downlink, improvements of layer 2 protocols, and continuous packet connectivity.

In order to ensure the competitiveness of UMTS for the next 10 years and beyond, concepts for UMTS long term evolution (LTE) have been investigated. The objective is a high-data-rate, low-latency and packet-optimized radio access technology. Therefore, a study item was launched in 3GPP Release 7 on evolved UMTS terrestrial radio access (EUTRA) and evolved UMTS terrestrial radio access network (EUTRAN). LTE/EUTRA will then form part of 3GPP Release 8 core specifications.

This introduction focuses on LTE/EUTRA technology. In the following, the terms LTE or EUTRA are used interchangeably.

In the context of the LTE study item, 3GPP work first focused on the definition of requirements, e.g. targets for data rate, capacity, spectrum efficiency, and latency. Also commercial aspects such as costs for installing and operating the network were considered. Based on these requirements, technical concepts for the air interface transmission schemes and protocols were studied. Notably, LTE uses new multiple access schemes on the air interface: orthogonal frequency division multiple access (OFDMA) in downlink and single carrier frequency division multiple access (SC-FDMA) in uplink. Furthermore, MIMO antenna schemes form an essential part of LTE. In an attempt to simplify protocol architecture, LTE brings some major changes to the existing UMTS protocol concepts. Impact on the overall network architecture including the core network is being investigated in the context of 3GPP system architecture evolution (SAE).

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1.1 Requirements for UMTS Long-Term Evolution

LTE is focusing on optimum support of packet switched (PS) services. Main requirements for the design of an LTE system are documented in 3GPP TR 25.913 [1] and can be summarized as follows:

- Data Rate: Peak data rates target 100 Mbps (downlink) and 50 Mbps (uplink) for 20 MHz spectrum allocation, assuming two receive antennas and one transmit antenna are at the terminal.
- Throughput: The target for downlink average user throughput per MHz is three to four times better than Release 6. The target for uplink average user throughput per MHz is two to three times better than Release 6.
- Spectrum efficiency: The downlink target is three to four times better than Release 6. The uplink target is two to three times better than Release 6.
- Latency: The one-way transit time between a packet being available at the IP layer in either the UE or radio access network and the availability of this packet at IP layer in the radio access network/UE shall be less than 5 ms. Also C-plane latency shall be reduced, e.g. to allow fast transition times of less than 100 ms from camped state to active state.
- Bandwidth: Scaleable bandwidths of 5 MHz, 10 MHz, 15 MHz, and 20 MHz shall be supported. Also bandwidths smaller than 5 MHz shall be supported for more flexibility.
- Interworking: Interworking with existing UTRAN/GERAN systems and non-3GPP systems shall be ensured. Multimode terminals shall support handover to and from UTRAN and GERAN as well as inter-RAT measurements. Interruption time for handover between EUTRAN and UTRAN/GERAN shall be less than 300 ms for realtime services and less than 500 ms for non-realtime services.
- Multimedia broadcast multicast services (MBMS): MBMS shall be further enhanced and is then referred to as E-MBMS.
- Costs: Reduced CAPEX and OPEX including backhaul shall be achieved. Costeffective migration from Release 6 UTRA radio interface and architecture shall be possible. Reasonable system and terminal complexity, cost, and power consumption shall be ensured. All the interfaces specified shall be open for multivendor equipment interoperability.
- Mobility: The system should be optimized for low mobile speed (0 to 15 km/h), but higher mobile speeds shall be supported as well, including high speed train environment as a special case.
- Spectrum allocation: Operation in paired (frequency division duplex / FDD mode) and unpaired spectrum (time division duplex / TDD mode) is possible.
- Co-existence: Co-existence in the same geographical area and co-location with GERAN/UTRAN shall be ensured. Also, co-existence between operators in adjacent bands as well as cross-border co-existence is a requirement.
- Quality of Service: End-to-end quality of service (QoS) shall be supported. VoIP should be supported with at least as good radio and backhaul efficiency and latency as voice traffic over the UMTS circuit switched networks.
- Network synchronization: Time synchronization of different network sites shall not be mandated.

1.2 Long-Term Evolution Downlink Transmission Scheme

1.2.1 OFDMA

The downlink transmission scheme for EUTRA FDD and TDD modes is based on conventional OFDM.

In an OFDM system, the available spectrum is divided into multiple carriers, called subcarriers, which are orthogonal to each other. Each of these subcarriers is independently modulated by a low rate data stream.

OFDM is used as well in WLAN, WiMAX and broadcast technologies like DVB. OFDM has several benefits including its robustness against multipath fading and its efficient receiver architecture.

figure 1-1 shows a representation of an OFDM signal taken from 3GPP TR 25.892 [2]. In this figure, a signal with 5 MHz bandwidth is shown, but the principle is of course the same for the other EUTRA bandwidths. Data symbols are independently modulated and transmitted over a high number of closely spaced orthogonal subcarriers. In EUTRA, downlink modulation schemes QPSK, 16QAM, and 64QAM are available.

In the time domain, a guard interval may be added to each symbol to combat inter-OFDM-symbol-interference due to channel delay spread. In EUTRA, the guard interval is a cyclic prefix which is inserted prior to each OFDM symbol.

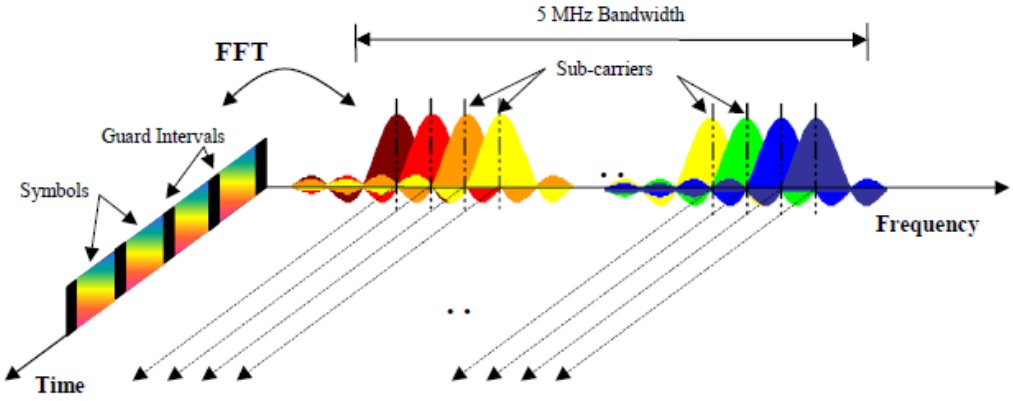

Fig. 1-1: Frequency-Time Representation of an OFDM Signal

In practice, the OFDM signal can be generated using the inverse fast Fourier transform (IFFT) digital signal processing. The IFFT converts a number N of complex data symbols used as frequency domain bins into the time domain signal. Such an N-point IFFT is illustrated in figure 1-2, where a(mN+n) refers to the n^{th} subchannel modulated data symbol, during the time period $mT_u < t \leq (m+1)T_u$.

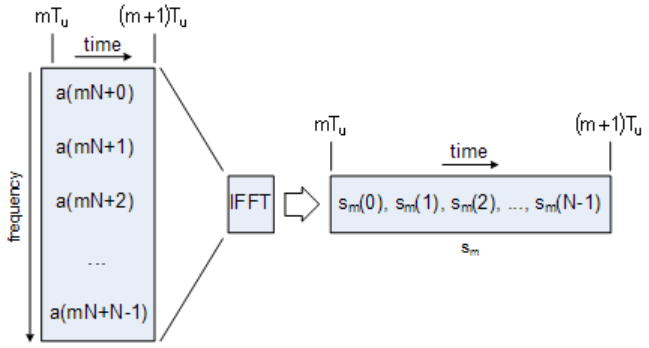

Fig. 1-2: OFDM useful symbol generation using an IFFT

The vector s_m is defined as the useful OFDM symbol. It is the time superposition of the N narrowband modulated subcarriers. Therefore, from a parallel stream of N sources of data, each one independently modulated, a waveform composed of N orthogonal subcarriers is obtained, with each subcarrier having the shape of a frequency sinc function (see figure 1-1).

figure 1-3 illustrates the mapping from a serial stream of QAM symbols to N parallel streams, used as frequency domain bins for the IFFT. The N-point time domain blocks obtained from the IFFT are then serialized to create a time domain signal. Not shown in figure 1-3 is the process of cyclic prefix insertion.

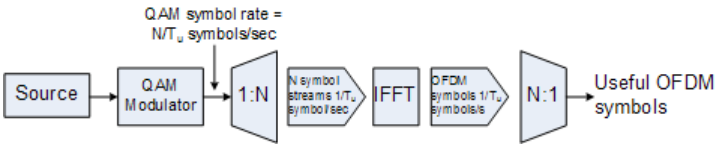

Fig. 1-3: OFDM Signal Generation Chain

In contrast to an OFDM transmission scheme, OFDMA allows the access of multiple users on the available bandwidth. Each user is assigned a specific time-frequency resource. As a fundamental principle of EUTRA, the data channels are shared channels, i.e. for each transmission time interval of 1 ms, a new scheduling decision is taken regarding which users are assigned to which time/frequency resources during this transmission time interval.

1.2.2 OFDMA Parameterization

A generic frame structure is defined for both EUTRA FDD and TDD modes. Additionally, an alternative frame structure is defined for the TDD mode only. The EUTRA frame structures are defined in 3GPP TS 36.211. For the generic frame structure, the 10 ms radio frame is divided into 20 equally sized slots of 0.5 ms. A subframe consists of two consecutive slots, so one radio frame contains 10 subframes. This is illustrated in figure 1-4 (T_s expresses the basic time unit corresponding to 30.72 MHz).

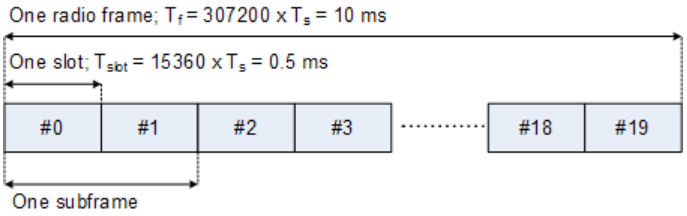

Fig. 1-4: Generic Frame Structure in EUTRA Downlink

figure 1-5shows the structure of the downlink resource grid for the duration of one downlink slot. The available downlink bandwidth consists of N_{BW}^{DL} subcarriers with a spacing of Δf = 15 kHz. In the case of multi-cell MBMS transmission, a subcarrier spacing of Δf = 7.5 kHz is also possible. N_{BW}^{DL} can vary in order to allow for scalable bandwidth operation up to 20 MHz. Initially, the bandwidths for LTE were explicitly defined within layer 1 specifications. Later on a bandwidth agnostic layer 1 was introduced, with N_{BW}^{DL} for the different bandwidths to be specified by 3GPP RAN4 to meet performance requirements, e.g. for out-of-band emission requirements and regulatory emission limits.

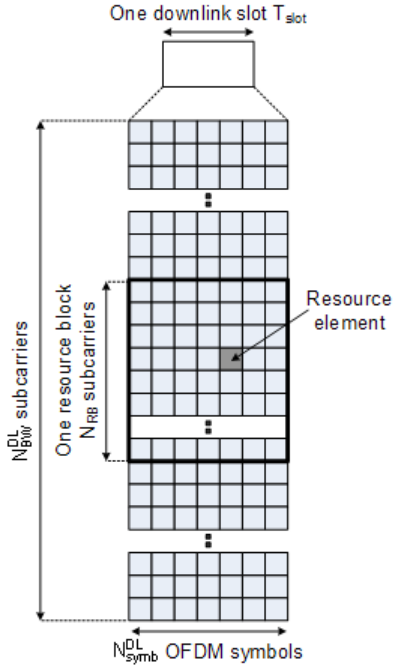

Fig. 1-5: Downlink Resource Grid

One downlink slot consists of N_{Symb}^{DL} OFDM symbols. To each symbol, a cyclic prefix (CP) is appended as guard time, compare figure 1-1. N_{Symb}^{DL} depends on the cyclic prefix length. The generic frame structure with normal cyclic prefix length contains N_{Symb}^{DL} = 7 symbols. This translates into a cyclic prefix length of T_{CP}≈5.2µs for the first symbol and T_{CP}≈4.7µs for the remaining 6 symbols. Additionally, an extended cyclic prefix is defined in order to cover large cell scenarios with higher delay spread and MBMS transmission. The generic frame structure with extended cyclic prefix of $T_{CP\text{-}E}$≈16.7µs contains N_{Symb}^{DL} = 6 OFDM symbols (subcarrier spacing 15 kHz). The generic frame structure with extended cyclic prefix

of T_{CP-E}≈33.3µs contains N_{symb}^{DL} = 3 symbols (subcarrier spacing 7.5 kHz). table 1-1 gives an overview of the different parameters for the generic frame structure.

Table 1-1: Parameters for Downlink Generic Frame Structure

Configuration	Number of Symbols N_{symb}^{DL}	Cyclic Prefix Length in Samples	Cyclic Prefix Length in µs
Normal cyclic prefix Δf=15 kHz	7	160 for first symbol 144 for other symbols	5.2 µs for first symbol 4.7 µs for other symbols
Extended cyclic prefix Δf=15 kHz	6	512	16.7 µs
Extended cyclic prefix Δf=7.5 kHz	3	1024	33.3 µs

1.2.3 Downlink Data Transmission

Data is allocated to the UEs in terms of resource blocks. A physical resource block consists of 12 (24) consecutive subcarriers in the frequency domain for the Δf=15 kHz (Δf=7.5 kHz) case. In the time domain, a physical resource block consists of DL N_{symb} consecutive OFDM symbols, see figure 1-5. N_{symb}^{DL} is equal to the number of OFDM symbols in a slot. The resource block size is the same for all bandwidths, therefore the number of available physical resource blocks depends on the bandwidth. Depending on the required data rate, each UE can be assigned one or more resource blocks in each transmission time interval of 1 ms. The scheduling decision is done in the base station (eNodeB). The user data is carried on the physical downlink shared channel (PDSCH). Downlink control signaling on the physical downlink control channel (PDCCH) is used to convey the scheduling decisions to individual UEs. The PDCCH is located in the first OFDM symbols of a slot.

1.2.4 Downlink Reference Signal Structure and Cell Search

The downlink reference signal structure is important for cell search, channel estimation and neighbor cell monitoring. figure 1-6 shows the principle of the downlink reference signal structure for one-antenna, two-antenna, and four-antenna transmission. Specific predefined resource elements in the time-frequency domain carry the reference signal sequence. Besides first reference symbols, there may be a need for second reference symbols. The different colors in figure 1-6 represent the sequences transmitted from up to four transmit antennas.

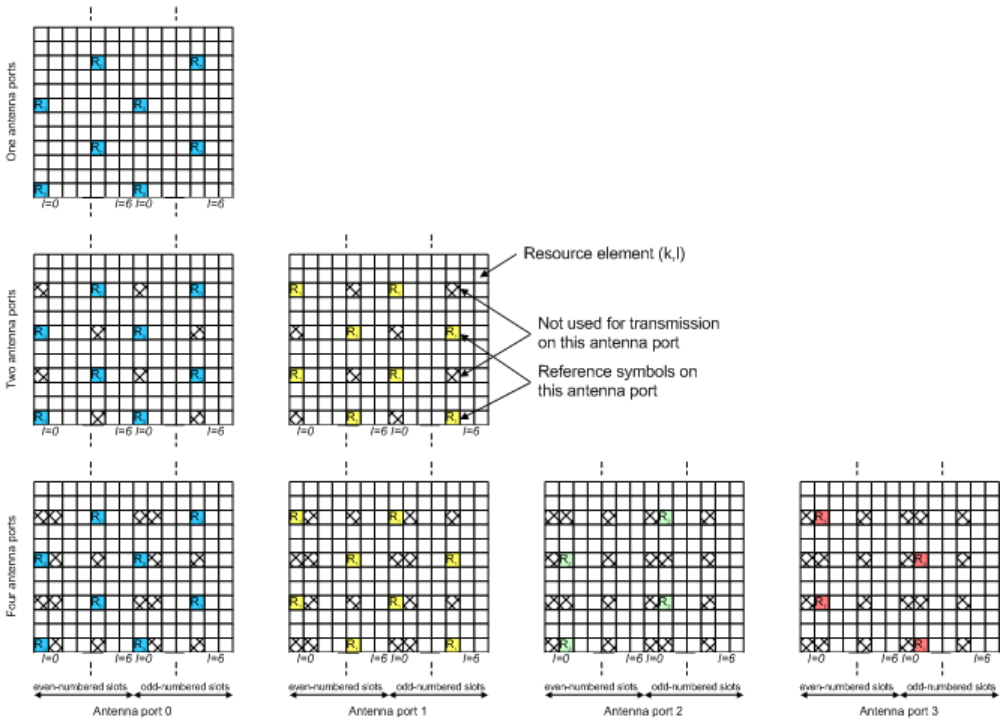

Fig. 1-6: Downlink Reference Signal Structure (Normal Cyclic Prefix)

The reference signal sequence carries the cell identity. Each reference signal sequence is generated as a symbol-by-symbol product of an orthogonal sequence r^{OS} (three of them existing) and a pseudo-random sequence r^{PRS} (170 of them existing). Each cell identity corresponds to a unique combination of one orthogonal sequence r^{OS} and one pseudo-random sequence r^{PRS}, allowing 510 different cell identities.

Frequency hopping can be applied to the downlink reference signals. The frequency hopping pattern has a period of one frame (10 ms).

During cell search, different types of information need to be identified by the handset: symbol and radio frame timing, frequency, cell identification, overall transmission bandwidth, antenna configuration, and cyclic prefix length.

Besides the reference symbols, synchronization signals are therefore needed during cell search. EUTRA uses a hierarchical cell search scheme similar to WCDMA. This means that the synchronization acquisition and the cell group identifier are obtained from different synchronization signals. Thus, a primary synchronization signal (P-SYNC) and a secondary synchronization signal (S-SYNC) are assigned a predefined structure. They are transmitted on the 72 center subcarriers (around the DC subcarrier) within the same predefined slots (twice per 10 ms) on different resource elements, see figure 1-7.

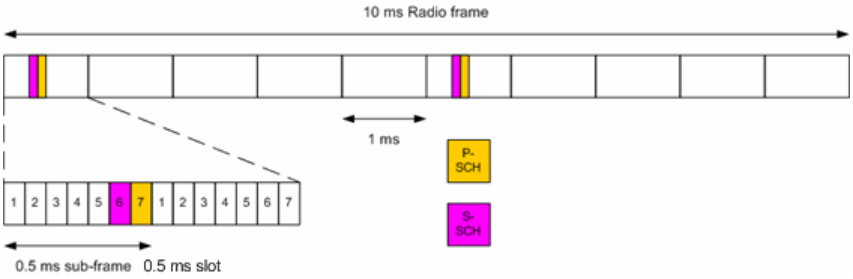

Fig. 1-7: P-SYNC and S-SYNC Structure

As additional help during cell search, a common control physical channel (CCPCH) is available which carries BCH type of information, e.g. system bandwidth. It is transmitted at predefined time instants on the 72 subcarriers centered around the DC subcarrier.

In order to enable the UE to support this cell search concept, it was agreed to have a minimum UE bandwidth reception capability of 20 MHz.

1.2.5 Downlink Physical Layer Procedures

For EUTRA, the following downlink physical layer procedures are especially important:

- **Cell search and synchronization**
  See above.
- **Scheduling**
  Scheduling is done in the base station (eNodeB). The downlink control channel PDCCH informs the users about their allocated time/frequency resources and the transmission formats to use. The scheduler evaluates different types of information, e.g. quality of service parameters, measurements from the UE, UE capabilities, and buffer status.
- **Link adaptation**
  Link adaptation is already known from HSDPA as adaptive modulation and coding. Also in EUTRA, modulation and coding for the shared data channel is not fixed, but rather is adapted according to radio link quality. For this purpose, the UE regularly reports channel quality indications (CQI) to the eNodeB.
- **Hybrid automatic repeat request (ARQ)**
  Downlink hybrid ARQ is also known from HSDPA. It is a retransmission protocol. The UE can request retransmissions of incorrectly received data packets.

1.3 References

[1] 3GPP TS 25.913: Requirements for E-UTRA and E-UTRAN (Release 7)

[2] 3GPP TR 25.892: Feasibility Study for Orthogonal Frequency Division Multiplexing (OFDM) for UTRAN enhancement (Release 6)

[3] 3GPP TS 36.211 v8.3.0: Physical Channels and Modulation (Release 8)

[4] 3GPP TS 36.300: E-UTRA and E-UTRAN; Overall Description; Stage 2 (Release 8)

[5] 3GPP TS 22.978: All-IP Network (AIPN) feasibility study (Release 7)

[6] 3GPP TS 25.213: Spreading and modulation (FDD)

[7] Speth, M., Fechtel, S., Fock, G., and Meyr, H.: Optimum Receiver Design for Wireless Broad-Band Systems Using OFDM – Part I. IEEE Trans. on Commun. Vol. 47 (1999) No. 11, pp. 1668-1677.

[8] Speth, M., Fechtel, S., Fock, G., and Meyr, H.: Optimum Receiver Design for OFDM-Based Broadband Transmission – Part II: A Case Study. IEEE Trans. on Commun. Vol. 49 (2001) No. 4, pp. 571-578.

2 Welcome

The EUTRA/LTE software application makes use of the I/Q capture functionality of the following spectrum and signal analyzers to enable EUTRA/LTE TX measurements conforming to the EUTRA specification.

- R&S FSV

This manual contains all information necessary to configure, perform and analyze such measurements.

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2.1 Installing the Software

For information on the installation procedure see the release notes of the R&S FSV.

2.2 Application Overview

Starting the application

Access the application via the "Mode" menu.

► Press the MODE key and select "LTE".
Note that you may have to browse through the "Mode" menu with the "More" softkey to find the LTE entry.

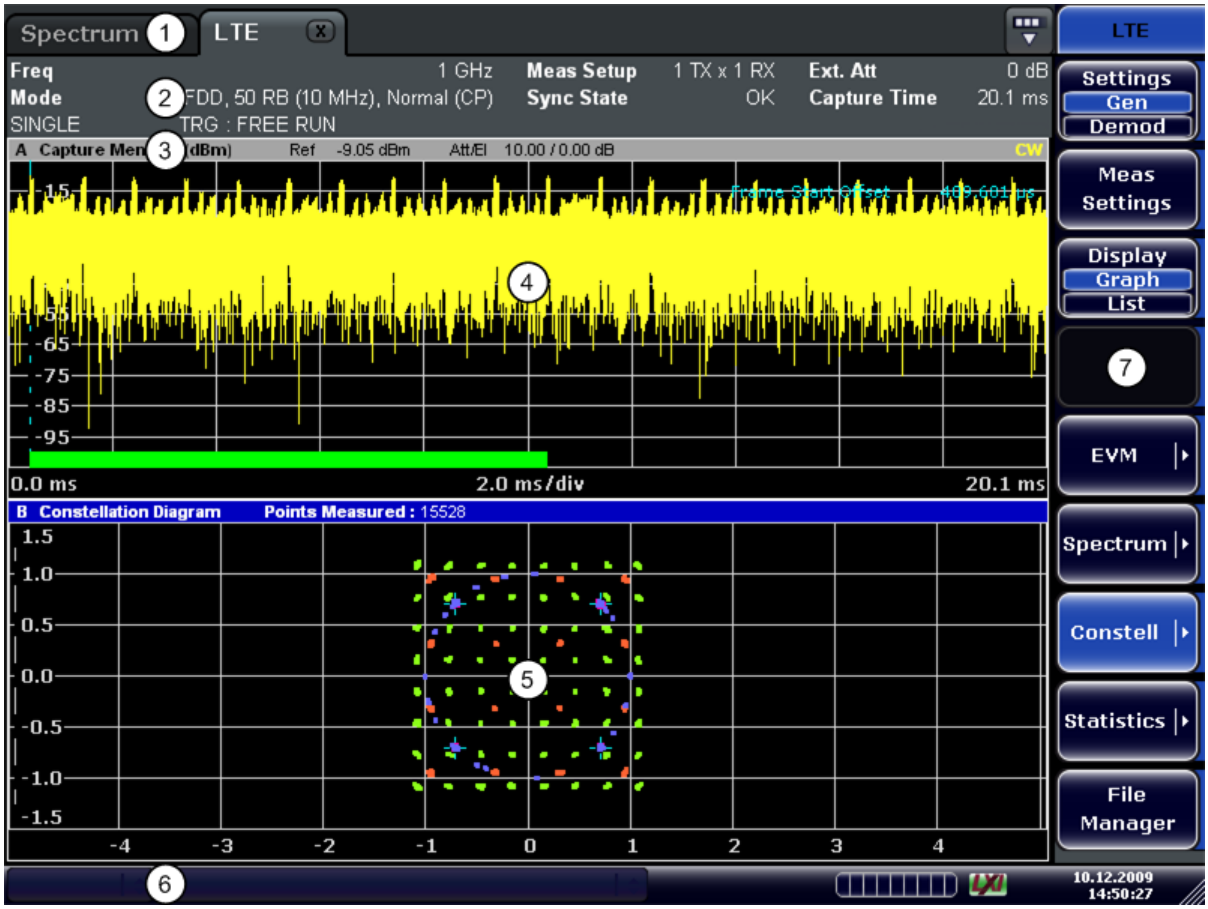
Presetting the software

When you first start the software, all settings are in their default state. After you have changed any parameter, you can restore the default state with the PRESET key.

`CONFigure:PRESet` on page 151

Elements and layout of the user interface

The user interface of the LTE measurement application is made up of several elements.



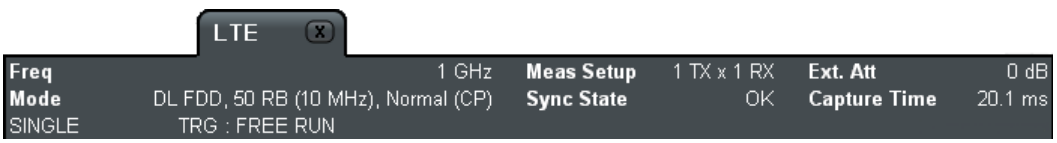
1 = Channel Bar: contains all currently active measurement applications
2 = Table Header: shows basic measurement information, e.g. the frequency
3 = Result Display Header: shows information about the trace
4 = Result Display Screen A: shows the measurement results
5 = Result Display Screen B: shows the measurement results
6 = Status Bar: shows the measurement progress, software messages and errors
7 = Softkeys: open settings dialogs and select result displays

The status bar

The status bar is located at the bottom of the display. It shows the current measurement status and its progress in a running measurement. The status bar also shows warning and error messages. Error messages are generally highlighted.

Display of measurement settings

The header table above the result displays shows information on hardware and measurement settings.


LTE
Freq 1 GHz
Mode DL FDD, 50 RB (10 MHz), Normal (CP)
SINGLE TRG : FREE RUN
Meas Setup 1 TX x 1 RX
Sync State OK
Ext. Att 0 dB
Capture Time 20.1 ms

The header table includes the following information

- **Freq**
  The analyzer RF frequency.
- **Mode**
  Link direction, duplexing, cyclic prefix and maximum number of physical resource blocks (PRBs) / signal bandwidth.
- **Meas Setup**
  Shows number of transmitting and receiving antennas.
- **Sync State**
  The following synchronization states may occur:
  – **OK** The synchronization was successful.
  – **FAIL (C)** The cyclic prefix correlation failed.
  – **FAIL (P)** The P-SYNC correlation failed.
  – **FAIL (S)** The S-SYNC correlation failed.

  Any combination of C, P and S may occur.
  SCPI Command:
  `[SENSe]:SYNC[:STATe]?` on page 97
- **Ext. Att**
  Shows the external attenuation in dB.
- **Capture Time**
  Shows the capture length in ms.

2.3 Support

If you encounter any problems when using the application, you can contact the Rohde & Schwarz support to get help for the problem.

To make the solution easier, use the "R&S Support" softkey to export useful information for troubleshooting. The R&S FSV stores the information in a number of files that are located in the R&S FSV directory `C:\R_S\Instr\user\LTE\Support`. If you contact Rohde & Schwarz to get help on a certain problem, send these files to the support in order to identify and solve the problem faster.

3 Measurement Basics

This chapter provides background information on the measurements and result displays available with the LTE Analysis Software.

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- The LTE Downlink Analysis Measurement Application....20
- Performing Time Alignment Measurements....23
- Performing Transmit On/Off Power Measurements....25

3.1 Symbols and Variables

The following chapters use various symbols and variables in the equations that the measurements are based on. The table below explains these symbols for a better understanding of the measurement principles.

$a_{l,k}\hat{a}_{l,k}$	data symbol (actual, decided)
$b_{l,k}$	boosting factor
Δf, $\Delta \hat{f}_{coarse}$	carrier frequency offset between transmitter and receiver (actual, coarse estimate)
Δf_{res}	residual carrier frequency offset
ζ	relative sampling frequency offset
$H_{l,k}$, $\hat{H}_{l,k}$	channel transfer function (actual, estimate)
i	time index
$\hat{i}_{coarse}$, $\hat{i}_{fine}$	timing estimate (coarse, fine)
k	subcarrier index
l	OFDM symbol index
N_{FFT}	length of FFT
N_g	number of samples in cyclic prefix (guard interval)
N_s	number of Nyquist samples
N_{RE}	number of resource elements
n	subchannel index, subframe index
$n_{l,k}$	noise sample
Φ_l	common phase error
r(i)	received sample in the time domain
$r_{l,k}$, $r'_{l,k}$, $r''_{l,k}$	received sample (uncompensated, partially compensated, equalized) in the frequency domain

T	useful symbol time
T_g	guard time
T_s	symbol time

3.2 Overview

The digital signal processing (DSP) involves several stages until the software can present results like the EVM.

The contents of this chapter are structered like the DSP.

3.3 The LTE Downlink Analysis Measurement Application

The block diagram in figure 3-1 shows the EUTRA/LTE downlink measurement application from the capture buffer containing the I/Q data to the actual analysis block. The outcome of the fully compensated reference path (green) are the estimates $\hat{a}_{l,k}$ of the transmitted data symbols $a_{l,k}$. Depending on the user-defined compensation, the received samples $r''_{l,k}$ of the measurement path (yellow) still contain the transmitted signal impairments of interest. The analysis block reveals these impairments by comparing the reference and the measurement path. Prior to the analysis, diverse synchronization and channel estimation tasks have to be accomplished.

3.3.1 Synchronization

The first of the synchronization tasks is to estimate the OFDM symbol timing, which coarsely estimates both timing and carrier frequency offset. The frame synchronization block determines the position of the P-/S-Sync symbols in time and frequency by using the coarse fractional frequency offset compensated capture buffer and the timing estimate $\hat{\tau}_{coarse}$ to position the window of the FFT. If no P-/S-Sync is available in the signal, the reference signal is used for synchronization. The fine timing block prior to the FFT allows a timing improvement and makes sure that the EVM window is centered on the measured cyclic prefix of the considered OFDM symbol. For the 3GPP EVM calculation according to 3GPP TS 36.211 (v8.9.0), the block “window” produces three signals taken at the timing offsets $\Delta\tilde{\tau}$, $\Delta\tilde{\tau}_l$ and $\Delta\tilde{\tau}_h$. For the reference path, only the signal taken at the timing offset $\Delta\tilde{\tau}$ is used.

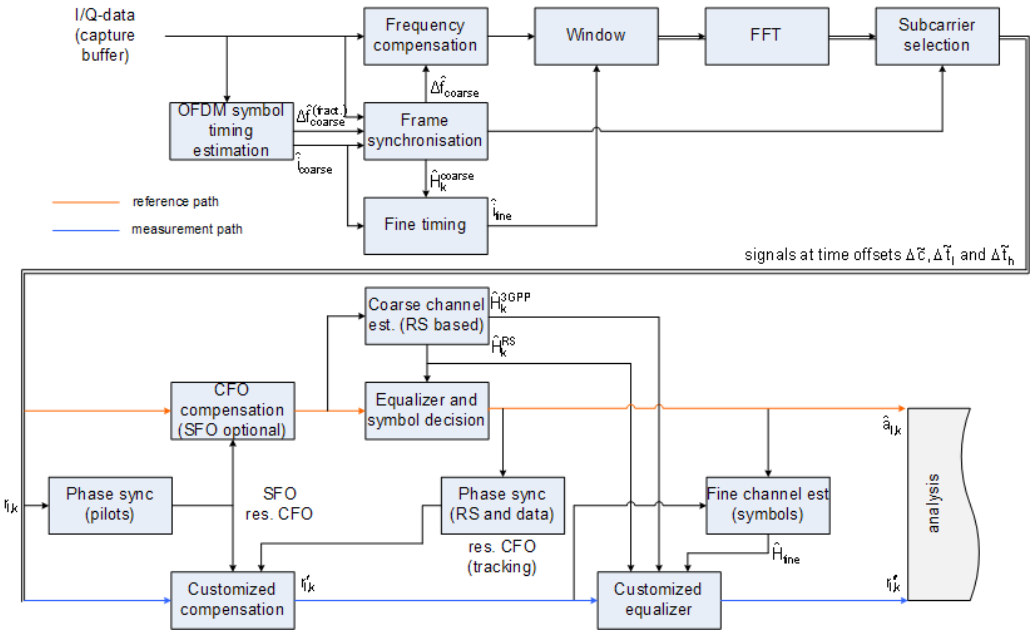


Fig. 3-1: Block diagram for the LTE DL measurement application

After the time to frequency transformation by an FFT of length N_{FFT}, the phase synchronization block is used to estimate the following:

- the relative sampling frequency offset ζ (SFO)
- the residual carrier frequency offset Δf_{res} (CFO)
- the common phase error Φ_l (CPE)

According to 3GPP TS 25.913 and 3GPP TR 25.892, the uncompensated samples can be expressed as

$$R_{l,k} = A_{l,k} \cdot H_{l,k} \cdot \underbrace{e^{j\Phi_l}}_{CPE} \cdot \underbrace{e^{j2\pi \cdot N_S / N_{FFT} \cdot \zeta \cdot k \cdot l}}_{SFO} \cdot \underbrace{e^{j2\pi \cdot N_S / N_{FFT} \cdot \Delta f_{res} \cdot T \cdot l}}_{res.CFO} + N_{l,k} \qquad (3 - 1)$$

where

- the data symbol is $a_{l,k}$, on subcarrier k at OFDM symbol l
- the channel transfer function is $h_{l,k}$
- the number of Nyquist samples is N_s within the symbol time T_s
- the useful symbol time $T=T_s-T_g$
- the independent and Gaussian distributed noise sample is $n_{l,k}$

Within one OFDM symbol, both the CPE and the residual CFO cause the same phase rotation for each subcarrier, while the rotation due to the SFO depends linearly on the subcarrier index. A linear phase increase in symbol direction can be observed for the residual CFO as well as for the SFO.

The results of the tracking estimation block are used to compensate the samples $r_{l,k}$

Whereas a full compensation is performed in the reference path, the signal impairments that are of interest to the user are left uncompensated in the measurement path.

After having decided the data symbols in the reference path, an additional phase tracking can be utilized to refine the CPE estimation.

3.3.2 Channel Estimation and Equalizitaion

As shown in figure 3-1, there is one coarse and one fine channel estimation block. The reference signal-based coarse estimation is tapped behind the CFO compensation block (SFO compensation can optionally be enabled) of the reference path. The coarse estimation block uses the reference signal symbols to determine estimates of the channel transfer function by interpolation in both time and frequency direction. A special channel estimation ($\hat{H}_k^{3GPP}$) as defined in 3GPP TS 36.211 is additionally generated. The coarse estimation results are used to equalize the samples of the reference path prior to symbol decision. Based on the decided data symbols, a fine channel estimation is optimally performed and then used to equalize the partially compensated samples of the measurement path.

3.3.3 Analysis

The analysis block of the EUTRA/LTE downlink measurement application allows to compute a variety of measurement variables.

EVM

The error vector magnitude (EVM) measurement results 'EVM PDSCH QPSK/16-QAM/ 64-QAM' are calculated according to the specification in 3GPP TS 36.211.

All other EVM measurement results are calculated according to

$$EVM_{l,k} = \frac{\left| r''_{l,k} - \hat{a}_{l,k} \right|}{b_{l,k} \sqrt{E\left\{ \left| \frac{a_{l,k}}{b_{l,k}} \right|^2 \right\}}} \qquad (3 - 2)$$

on subcarrier k at OFDM symbol l, where $b_{l,k}$ is the boosting factor. Since the average power of all possible constellations is 1 when no boosting is applied, the equation can be rewritten as

$$EVM_{n,l} = \frac{\left| r''_{l,k} - \hat{a}_{l,k} \right|}{b_{l,k}} \qquad (3 - 3)$$

The average EVM of all data subcarriers is then

$$EVM_{data} = \sqrt{\frac{1}{N_{REdata}} \sum_{l} \sum_{k_{data}} EVM_{l,k_{data}}^{2}}$$

(3 - 4)

The number of resource elements taken into account is denoted by $N_{RE\ data}$.

I/Q imbalance

The I/Q imbalance can be written as

$$r(t) = I\,\Re\{s(t)\} + jQ\,\Im\{s(t)\}$$

(3 - 5)

where s(t) is the transmit signal, r(t) is the received signal, and I and Q are the weighting factors. We define that I:=1 and Q:=1+ΔQ.

The I/Q imbalance estimation makes it possible to evaluate the

$$\text{modulator gain balance} = |1 + \Delta Q|$$

(3 - 6)

and the

$$\text{quadrature mismatch} = \arg\{1 + \Delta Q\}$$

(3 - 7)

based on the complex-valued estimate $\widehat{\Delta Q}$.

Other measurement variables

Without going into detail, the EUTRA/LTE downlink measurement application additionally provides the following results.

- Total power
- Constellation diagram
- Group delay
- I/Q offset
- Crest factor
- Spectral flatness

3.4 Performing Time Alignment Measurements

The MIMO measurement application provides the possibility to perform time alignment measurements between the different antennas for 2 or 4 TX antenna MIMO configurations. The time alignment error values represent the time offset between the considered antenna and antenna 1 and will be displayed in the result summary. A schematic description of the results is provided in figure 3-3.

A test setup for time alignment measurements is shown in figure 3-2. The dashed connections are only required for 4 TX antenna MIMO configuration. For best measurement result accuracy it is recommended to use cables of the same length and identical combiners as adders.

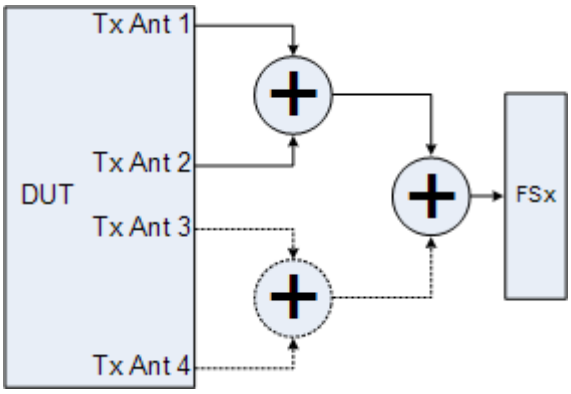


Fig. 3-2: Time alignment measurement hardware setup

For a successful time alignment measurement, make sure to set up the measurement correctly.

- the subframe selection in the general settings menu must be set to "All"
- enable "Compensate Crosstalk" in the demodulation settings, see screenshot below

Note that the time alignment measurement only uses the reference signal and therefore ignores any PDSCH settings (e.g. it does not have an influence on this measurement if the PDSCH MIMO scheme is set to transmit diversity or spatial multiplexing).

The EVM will usually be very high for this measurement. This does not effect the accuracy of the time alignment error measurement result.

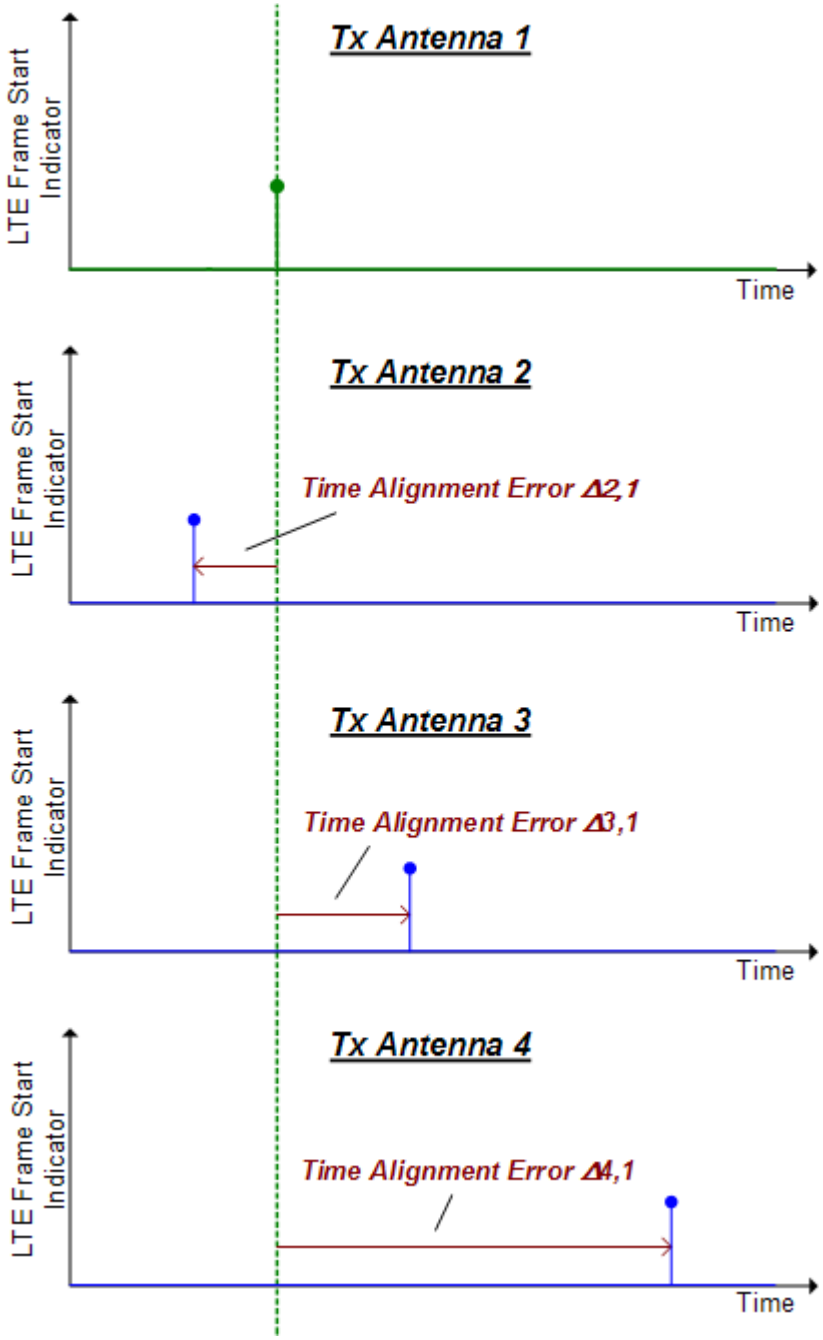


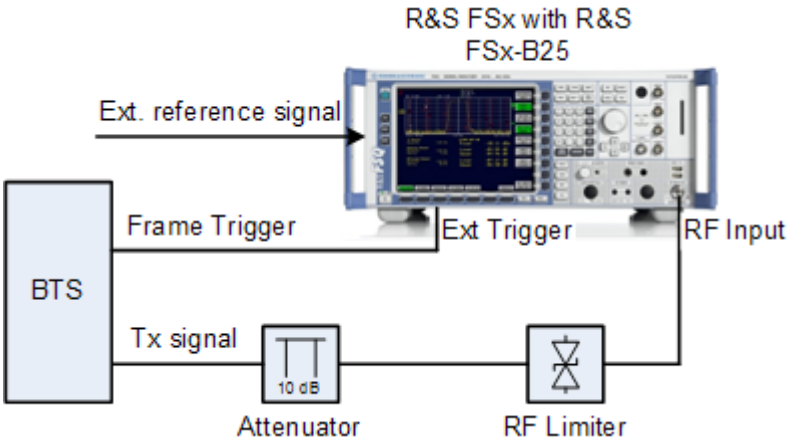
Fig. 3-3: Schematic description of the time alignment results

3.5 Performing Transmit On/Off Power Measurements

The technical specification in 3GPP TS 36.141 prescribes the measurement of the transmitter OFF power and the transmitter transient period of an EUTRA/LTE TDD base transceiver station (BTS) operating at its specified maximum output power. A special hardware setup is required for this measurement since the actual measurement is done

at very low power during the transmitter OFF periods requiring low attenuation at the analyzer input. The signal power during the transmitter ON periods in this test scenario is usually higher than the specified maximum input power of the R&S FSx signal analyzer and will cause severe damage to the analyzer if the measurement is not set up appropriately.

Test setup



To protect the analyzer input from damage, an RF limiter has to be applied at the analyzer input connector, as can be seen in figure 2-16. Table 1.1 shows the specifications the used limiter has to fulfill.

Min. acceptable CW input power	BTS output power minus 10 dB
Min. acceptable peak input power	BTS peak output power minus 10 dB
Max. output leakage	20 dBm
Max. response time	1 µs
Max. recovery time	1 µs

An additional 10 dB attenuation should be placed in front of the RF limiter to absorb eventual reflected waves because of the high VSWR of the limiter. The allowed maximum CW input power of the attenuator must be lower than the maximum output power of the BTS.

Performing the measurement

For the transmit ON/OFF power measurements according to 36.141, 6.4, the test model E-TM1.1 has to be used. For more information on loading the test model settings see chapter 7, "File Management", on page 84.

If an external trigger is used, before the actual measurement can be started, the timing must be adjusted by pressing the 'Adjust Timing' hotkey. The status display in the header of the graph changes from 'Timing not adjusted' to 'Timing adjusted' and the run hotkeys are released. Relevant setting changes again lead to a 'Timing not adjusted' status display.

If the adjustment fails, an error message is shown and the adjustment state is still "not adjusted". To find out what causes the synchronization failure, you should perform a regular EVM measurement (i.e. leave the ON/OFF Power measurement). Then you can use all the measurement results like EVM vs. Carrier to get more detailed information about the failure. The timing adjustment will succeed if the Sync State in the header is OK.

Using a R&S FSQ or R&S FSG it is recommended to use the external trigger mode since for high power signals a successful synchronization is not guaranteed under certain circumstances.

Pressing the 'Run Single' hotkey starts the averaging of the traces of the number of frames given in the 'General Settings' dialog. After performing all sweeps, the table in the upper half of the screen shows if the measurements pass or fail.

4 Measurements and Result Displays

The LTE measurement application features several measurements to examine and analyze different aspects of an LTE signal.

The source of the data that is processed is either a live signal or a previously recorded signal whose characteristics have been saved to a file. For more information see "Selecting the Input Source" on page 60.

- Numerical Results....28
- Measuring the Power Over Time....31
- Measuring the Error Vector Magnitude (EVM)....34
- Measuring the Spectrum....38
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- Measuring Statistics....45

4.1 Numerical Results

Result Summary....28

Result Summary
The Result Summary shows all relevant measurement results in numerical form, combined in one table.

▸ Press the "Display (List Graph)" softkey so that the "List" element turns blue to view the Result Summary.

SCPI command:

`DISPlay[:WINDow<n>]:TABLe` on page 93

Contents of the result summary

Result Summary						
Frame Result 1/1	Min	Mean	Limit	Max	Limit	Unit
EVM PDSCH QPSK		0.35	17.50			%
EVM PDSCH 16QAM			12.50			%
EVM PDSCH 64QAM			8.00			%
Time Alignment Error 2,1						ns
Time Alignment Error 3,1						ns
Time Alignment Error 4,1						ns
Results for Selection	Subframe(s) ALL	Selection Antenna 1		Frame Result 1/1		
EVM All	0.34	0.35		0.36		%
EVM Phys. Channel	0.34	0.35		0.36		%
EVM Phys. Signal	0.33	0.35		0.36		%
Frequency Error	- 35.44	- 35.36		- 35.26		Hz
Sampling Error	- 0.07	- 0.04		- 0.01		ppm
IQ Offset	- 68.33	- 67.16		- 66.53		dB
IQ Gain Imbalance	- 0.00	- 0.00		- 0.00		dB
IQ Quadrature Error	0.02	0.02		0.02		°
RSTP	- 57.96	- 57.95		- 57.95		dBm
OSTP	- 30.17	- 30.17		- 30.17		dBm
Power	- 30.25	- 30.23		- 30.22		dBm
Crest Factor		10.05				dB

The table is split in two parts. The first part shows results that refer to the complete frame. For each result, the minimum, mean and maximum values are displayed. It also indicates limit check results where available. The font of 'Pass' results is green and that of 'Fail' results is red.

In addition to the red font, the application also puts a red star (* 25.60) in front of failed results.

- **EVM PDSCH QPSK**
  Shows the EVM for all QPSK-modulated resource elements of the PDSCH channel in the analyzed frame.
  `FETCh:SUMMary:EVM:DSQP[:AVERage]?` on page 100
- **EVM PDSCH 16QAM**
  Shows the EVM for all 16QAM-modulated resource elements of the PDSCH channel in the analyzed frame.
  `FETCh:SUMMary:EVM:DSST[:AVERage]?` on page 100
- **EVM PDSCH 64QAM**
  Shows the EVM for all 64QAM-modulated resource elements of the PDSCH channel in the analyzed frame.
  `FETCh:SUMMary:EVM:DSSF[:AVERage]?` on page 101
- **Time Alignment Error 2,1 / 3,1 / 4,1**
  Shows the timing difference in MIMO setups between antenna 1 and another antenna (2, 3 or 4).
  `FETCh:SUMMary:TAE<antenna>?` on page 105

By default, all EVM results are in %. To view the EVM results in dB, change the EVM Unit.

The second part of the table shows results that refer to a specifc selection of the frame.

The statistic is always evaluated over the subframes.

The header row of the table contains information about the selection you have made (like the subframe).

- **EVM All**
  Shows the EVM for all resource elements in the analyzed frame.
  FETCh:SUMMary:EVM[:ALL][:AVERage]? on page 100
- **EVM Phys Channel**
  Shows the EVM for all physical channel resource elements in the analyzed frame.
  FETCh:SUMMary:EVM:PCHannel[:AVERage]? on page 101
- **EVM Phys Signal**
  Shows the EVM for all physical signal resource elements in the analyzed frame.
  FETCh:SUMMary:EVM:PSIGnal[:AVERage]? on page 101
- **Frequency Error**
  Shows the difference in the measured center frequency and the reference center frequency.
  FETCh:SUMMary:FERRor[:AVERage]? on page 102
- **Sampling Error**
  Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate.
  FETCh:SUMMary:SERRor[:AVERage]? on page 104
- **I/Q Offset**
  Shows the power at spectral line 0 normalized to the total transmitted power.
  FETCh:SUMMary:IQOFfset[:AVERage]? on page 103
- **I/Q Gain Imbalance**
  Shows the logarithm of the gain ratio of the Q-channel to the I-channel.
  FETCh:SUMMary:GIMBalance[:AVERage]? on page 102
- **I/Q Quadrature Error**
  Shows the measure of the phase angle between Q-channel and I-channel deviating from the ideal 90 degrees.
  FETCh:SUMMary:QUADerror[:AVERage]? on page 104
- **RSTP**
  Shows the reference signal transmit power as defined in 3GPP TS 36.141. It is required for the "DL RS Power" test.
  It is an average power and accumulates the powers of the reference symbols within a subframe divided by the number of reference symbols within a subframe.
  FETCh:SUMMary:RSTP[:AVERage]? on page 104
- **OSTP**
  Shows the OFDM symbol transmit power as defined in 3GPP TS 36.141.
  It accumulates all subcarrier powers of the 4th OFDM symbol. The 4th (out of 14 OFDM symbols within a subframe (in case of frame type 1, normal CP length)) contains exclusively PDSCH.
  FETCh:SUMMary:OSTP[:AVERage]? on page 103
- **Power**
  Shows the average time domain power of the analyzed signal.
  FETCh:SUMMary:POWer[:AVERage]? on page 103
- **Crest Factor**
  Shows the peak-to-average power ratio of captured signal.
  FETCh:SUMMary:CREStf[:AVERage]? on page 99

4.2 Measuring the Power Over Time

This chapter contains information on all measurements that show the power of a signal over time.

Capture Buffer.....31
On / Off Power.....32

Capture Buffer

The Capture Buffer result display shows the complete range of captured data for the last data capture. The x-axis represents time. The maximum value of the x-axis is equal to the Capture Time. The y-axis represents the amplitude of the captured I/Q data in dBm (for RF input).

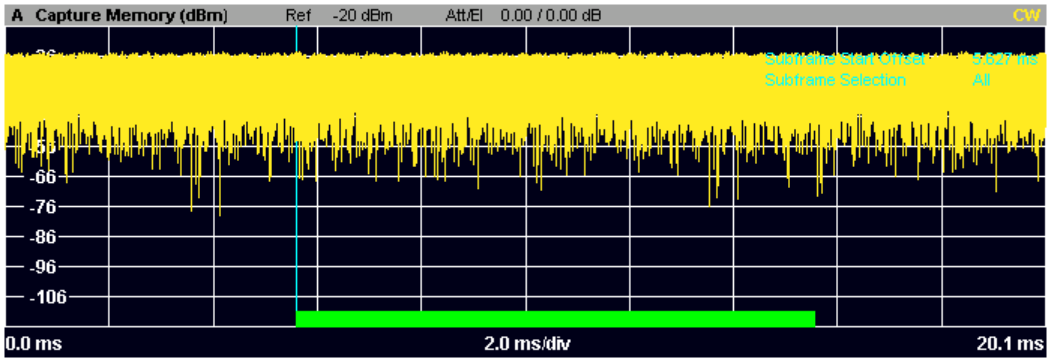


Fig. 4-1: Capture buffer without zoom

The header of the diagram shows the reference level, the mechanical and electrical attenuation and the trace mode.

The green bar at the bottom of the diagram represents the frame that is currently analyzed.

A blue vertical line at the beginning of the green bar in the Capture Buffer display represents the subframe start. Additionally, the diagram contains the "Subframe Start Offset" value. This value is the time difference between the subframe start and capture buffer start.

When you zoom into the diagram, you will see that the bar may be interrupted at certain positions. Each small bar indicates the useful parts of the OFDM symbol.

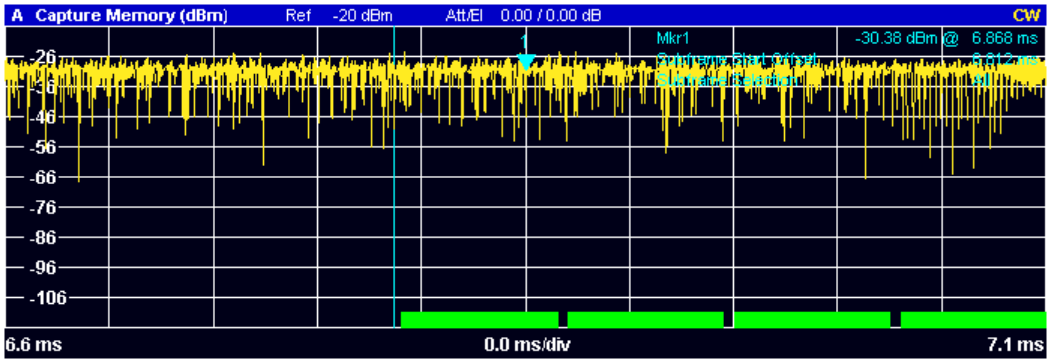


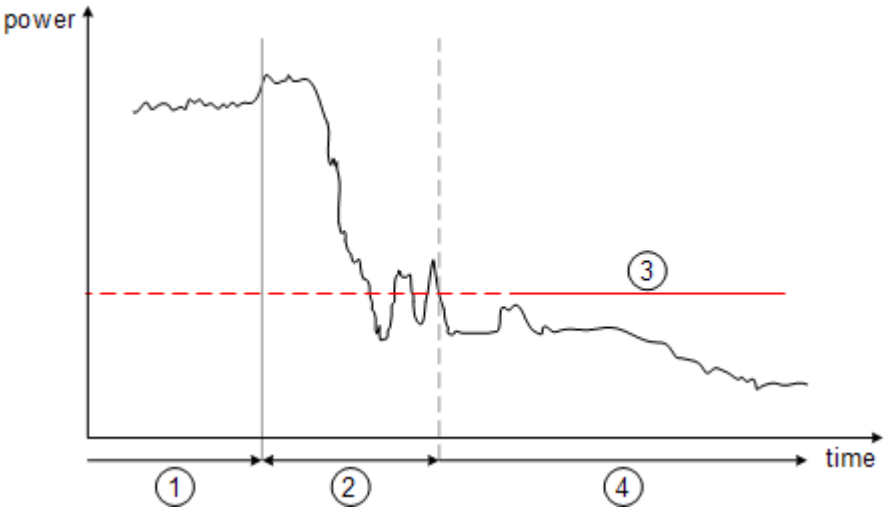
Fig. 4-2: Capture buffer after a zoom has been applied

Remote command:
CALCulate<n>:FEED 'PVT:CBUF'
TRACe:DATA?
Querying the subframe start offset:
`FETCh:SUMMary:TFRame?` on page 105

On / Off Power
The On / Off Power measurement shows the characteristics of an LTE TDD signal over time.

The measurement is designed to verify if the signal intervals during which no downlink signal is transmitted (reception or "off" periods) complies with the limits defined by 3GPP. Because the transition from transmission ("on" periods) to reception has to be very fast in order to efficiently use the resources, 3GPP has also defined limits for the transient periods. The limits for these are also verified by the measurement.

The transition from transmission to reception is an issue in TDD systems. Therefore, the measurement is available for TDD signals.



1 = subframe ("on" power period)
2 = transient
3 = "off" power density limit
4 = "off" power period

Note that the measurement works only if you are using the RF input. When you start the measurement, the R&S FSV records new I/Q data instead of using the data other I/Q measurements are based on.

For more information on setting up the measurement see chapter 3.5, "Performing Transmit On/Off Power Measurements", on page 25.

The result display for the On / Off Power measurement consists of numerical results and the graphic display of the signal characteristics.

Numerical results

The upper part of the result display shows the results in numerical form.

Each line of the table shows the characteristics of one "off" period.

A ON/OFF Power

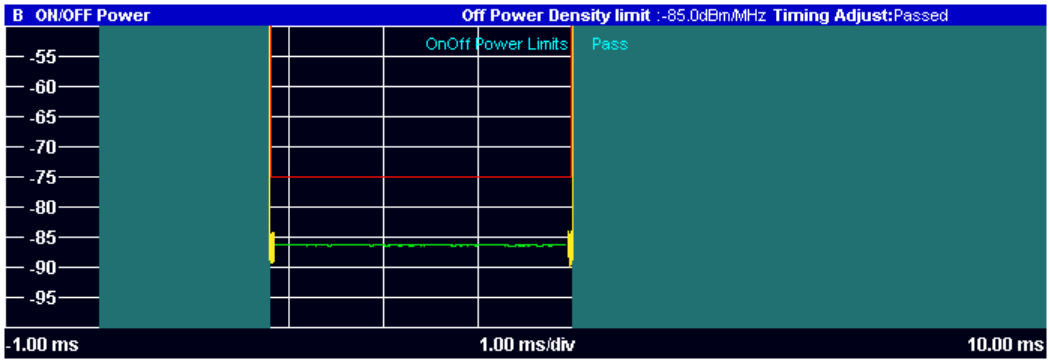
Start OFF Period Limit	Stop OFF Period Limit	Time at Δ to Limit	OFF Power Abs[dBm]	OFF Power Δ to Limit	Falling Trans. Period	Rising Trans. Period
1.838 ms	4.948 ms	2.962891 ms	-86.21 dBm	11.21 dB	2.41 µs	2.44 µs

- Start OFF Period Limit
  Shows the beginning of the "off" period relative to the frame start (0 seconds).
- Stop OFF Period Limit
  Shows the end of the "off" period relative to the frame start (0 seconds).
  The time from the start to the stop of the "off" period is the period over which the limits are checked. It corresponds to the yellow trace in the graphic result display.
- Time at Δ to Limit
  Shows the trace point at which the lowest distance between trace and limit line has been detected. The result is a time relative to the frame start.
- OFF Power Abs [dBm]
  Shows the absolute power of the signal at the trace point with the lowest distance to the limit line.
- OFF Power Δ to Limit
  Shows the distance between the trace and the limit line of the trace point with the lowest distance to the limit line in dB.
- Falling Transition Period
  Shows the length of the falling transient.
- Rising Transition Period
  Shows the length of the rising transient.
  Note that the beginning and end of a transition period is determined based on the "Off Power Density Limit". This limit is defined by 3GPP in TS 36.141 as the maximum allowed mean power spectral density. The length of the transient from "on" to "off" period is, for example, the distance from the detected end of the subframe to the last time that the signal power is above the measured mean power spectral density.

Results that comply to the limits are displayed in green. Any results that violate the limits defined by 3GPP are displayed in red.

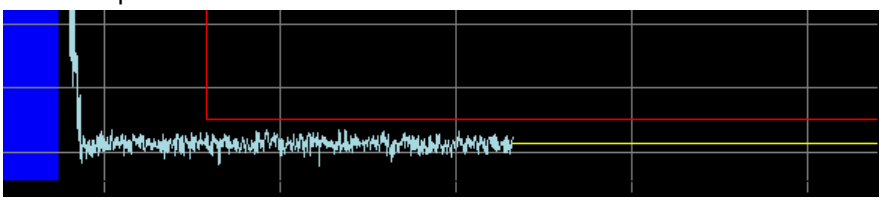
Graphic results

The lower part of the result display shows a graphical representation of the analyzed TDD frame.



The diagram consists of several elements.

- Yellow trace
  The yellow trace represents the signal power during the "off" periods. Filtering as defined in 3GPP TS 36.141 is taken into account for the calculation of the trace.
- Blue trace
  The blue trace represents the transition periods (falling and rising).
  Note that the blue trace might be visible only after zooming into the diagram because of its steep flank and small horizontal dimensions.



- Blue rectangles
  The blue rectangles represent the "on" periods. Because of the overload during the "on" periods, the actual signal power is only hinted at, not shown.

In addition to these elements, the diagram also shows the overall limit check (see above), the average count and the limit for the mean power spectral density ("Off Power Density Limit").

Remote command:
Selection:
CALCulate<n>:FEED 'PVT:OOP'
Limit check:
`CALCulate<n>:LIMit<k>:OOPower:OFFPower?` on page 117
`CALCulate<n>:LIMit<k>:OOPower:TRANsient?` on page 117
`[SENSe][:LTE]:OOPower:ATIMing` on page 97
TRACe:DATA?

4.3 Measuring the Error Vector Magnitude (EVM)

This chapter contains information on all measurements that show the error vector magnitude (EVM) of a signal.

The EVM is one of the most important indicators for the quality of a signal. For more information on EVM calculation methods refer to chapter 3, "Measurement Basics", on page 19.

EVM vs Carrier....35
EVM vs Symbol....36
Frequency Error vs Symbol....36
EVM vs Subframe....37

EVM vs Carrier
Starts the EVM vs Carrier result display.

This result display shows the Error Vector Magnitude (EVM) of the subcarriers. With the help of a marker, you can use it as a debugging technique to identify any subcarriers whose EVM is too high.

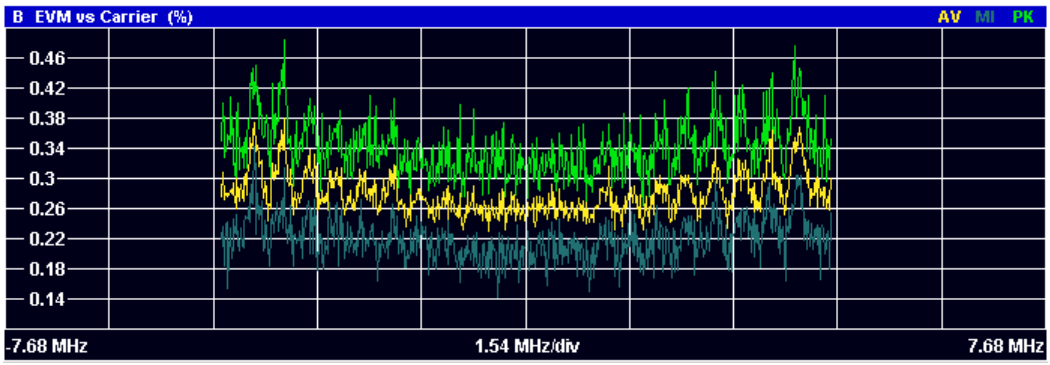
The results are based on an average EVM that is calculated over the resource elements for each subcarrier. This average subcarrier EVM is determined for each analyzed subframe in the capture buffer.

If you analyze all subframes, the result display contains three traces.

- Average EVM
  This trace shows the subcarrier EVM averaged over all subframes.
- Minimum EVM
  This trace shows the lowest (average) subcarrier EVM that has been found over the analyzed subframes.
- Maximum EVM
  This trace shows the highest (average) subcarrier EVM that has been found over the analyzed subframes.

If you select and analyze one subframe only, the result display contains one trace that shows the subcarrier EVM for that subframe only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 78

The x-axis represents the center frequencies of the subcarriers. On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.



Remote command:
CALCulate<n>:FEED 'EVM:EVCA'
TRACe:DATA?

EVM vs Symbol
Starts the EVM vs Symbol result display.

This result display shows the Error Vector Magnitude (EVM) of the OFDM symbols. You can use it as a debugging technique to identify any symbols whose EVM is too high.

The results are based on an average EVM that is calculated over all subcarriers that are part of a particular OFDM symbol. This average OFDM symbol EVM is determined for all OFDM symbols in each analyzed subframe.

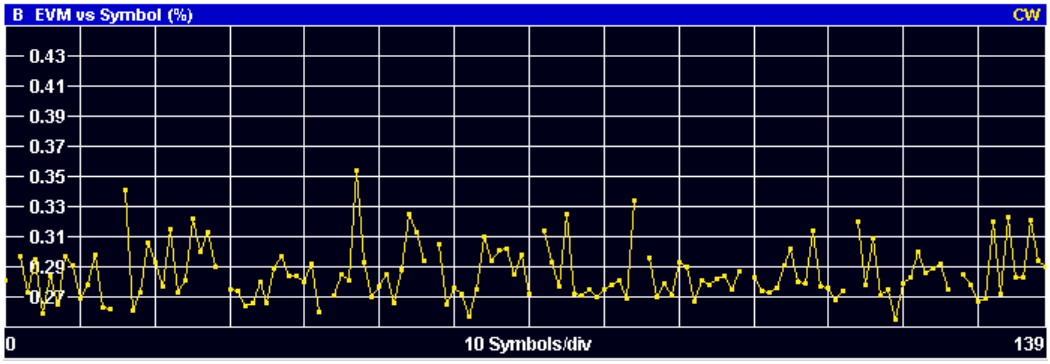
If you analyze all subframes, the result display contains three traces.

- Average EVM
  This trace shows the OFDM symbol EVM averaged over all subframes.
- Minimum EVM
  This trace shows the lowest (average) OFDM symbol EVM that has been found over the analyzed subframes.
- Maximum EVM
  This trace shows the highest (average) OFDM symbol EVM that has been found over the analyzed subframes.

If you select and analyze one subframe only, the result display contains one trace that shows the OFDM symbol EVM for that subframe only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 78

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the R&S FSV could not determine the EVM for that symbol. In case of TDD signals, the result display does not show OFDM symbols that are not part of the measured link direction.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit



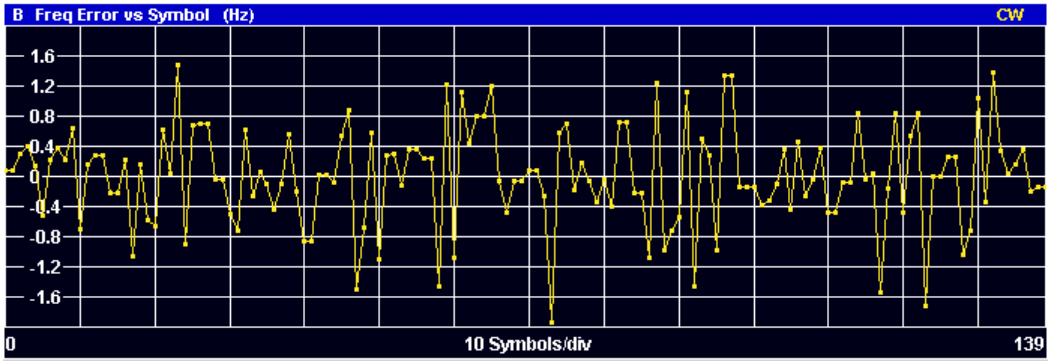
Remote command:
CALCulate<n>:FEED 'EVM:EVSY'
TRACe:DATA?

Frequency Error vs Symbol
Starts the Frequency Error vs Symbol result display.

This result display shows the Frequency Error on symbol level. You can use it as a debugging technique to identify any frequency errors within symbols.

The result is an average over all subcarriers.

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the R&S FSV could not determine the frequency error for that symbol. On the y-axis, the frequency error is plotted in Hz.



Remote command:
CALCulate<n>:FEED 'EVM:FEVS'
TRACe:DATA?

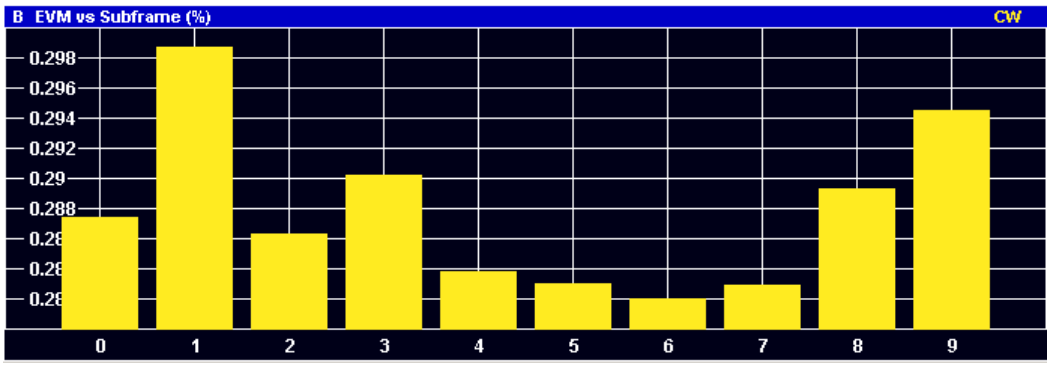
EVM vs Subframe
Starts the EVM vs Subframe result display.

This result display shows the Error Vector Magnitude (EVM) for each subframe. You can use it as a debugging technique to identify a subframe whose EVM is too high.

The result is an average over all subcarriers and symbols of a specific subframe.

The x-axis represents the subframes, with the number of displayed subframes being 10.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.



Remote command:
CALCulate<n>:FEED 'EVM:EVSU'
TRACe:DATA?

4.4 Measuring the Spectrum

This chapter contains information on all measurements that show the power of a signal in the frequency domain.

In addition to the I/Q measurements, spectrum measurements also include two frequency sweep measurements, the Spectrum Emission Mask and the Adjacent Channel Leakage Ratio.

- Frequency Sweep Measurements....38
- I/Q Measurements....41

4.4.1 Frequency Sweep Measurements

The Spectrum Emission Mask (SEM) and Adjacent Channel Leakage Ratio (ACLR) measurements are the only frequency sweep measurements available for the LTE measurement application. They do not use the I/Q data all other measurements use. Instead those measurements sweep the frequency spectrum every time you run a new measurement. Therefore it is not possible to to run an I/Q measurement and then view the results in the frequency sweep measurements and vice-versa. Also because each of the frequency sweep measurements uses different settings to obtain signal data it is not possible to run a frequency sweep measurement and view the results in another frequency sweep measurement.

Frequency sweep measurements are available if RF input is selected.

4.4.1.1 Available Measurements

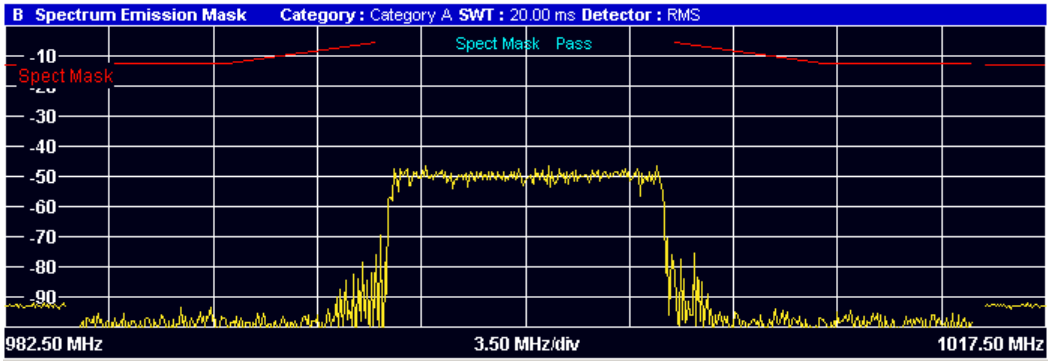
Spectrum Mask....38
ACLR....40

Spectrum Mask
Starts the Spectrum Emission Mask (SEM) result display.

The Spectrum Emission Mask measurement shows the quality of the measured signal by comparing the power values in the frequency range near the carrier against a spectral mask that is defined by the 3GPP specifications. In this way, you can test the performance of the DUT and identify the emissions and their distance to the limit.

In the diagram, the SEM is represented by a red line. If any measured power levels are above that limit line, the test fails. If all power levels are inside the specified limits, the test is passed. The R&S FSV puts a label to the limit line to indicate whether the limit check passed or failed.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel bandwidths. On the y-axis, the power is plotted in dBm.



A table above the result display contains the numerical values for the limit check at each check point:

- **Start / Stop Freq Rel**
  Shows the start and stop frequency of each section of the Spectrum Mask relative to the center frequency.
- **RBW**
  Shows the resolution bandwidth of each section of the Spectrum Mask
- **Freq at Δ to Limit**
  Shows the absolute frequency whose power measurement being closest to the limit line for the corresponding frequency segment.
- **Power Abs**
  Shows the absolute measured power of the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Power Rel**
  Shows the distance from the measured power to the limit line at the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Δ to Limit**
  Shows the minimal distance of the tolerance limit to the SEM trace for the corresponding frequency segment. Negative distances indicate the trace is below the tolerance limit, positive distances indicate the trace is above the tolerance limit.

A Spectrum Emission Mask List Ref -26.2 dBm Att/El 0.00 / 0.00 dB

Start Freq. Rel.	Stop Freq. Rel.	RBW	Freq. at Δ to Limit	Power Abs.	Power Rel.	Δ to Limit
-17.50 MHz	-15.50 MHz	1.00 MHz	983.453504000 MHz	-92.05 dBm	-61.65 dB	-79.05 dB
-15.05 MHz	-10.05 MHz	100.00 kHz	989.399040000 MHz	-93.46 dBm	-63.05 dB	-80.96 dB
-10.05 MHz	-5.05 MHz	100.00 kHz	994.950016000 MHz	-75.77 dBm	-45.37 dB	-70.27 dB
5.05 MHz	10.05 MHz	100.00 kHz	1.005665088 GHz	-75.44 dBm	-45.03 dB	-69.08 dB
10.05 MHz	15.05 MHz	100.00 kHz	1.010937472 GHz	-94.43 dBm	-64.03 dB	-81.93 dB
15.50 MHz	17.50 MHz	1.00 MHz	1.016883008 GHz	-92.15 dBm	-61.74 dB	-79.15 dB

Remote command:
CALCulate<n>:FEED 'SPEC:SEM'
TRACe:DATA?

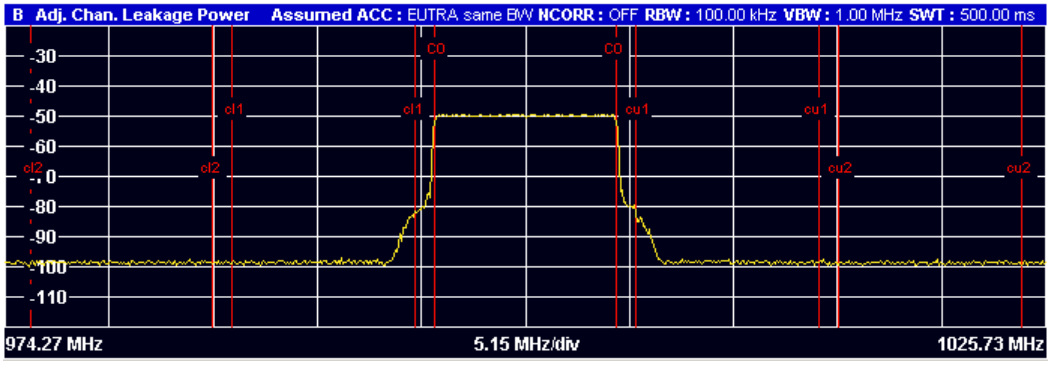
ACLR
Starts the Adjacent Channel Leakage Ratio (ACLR) measurement.

The ACLR measurement analyzes the power of one or two transmission channels and the power of the two neighboring channels (adjacent channels) to the left and right of the TX channels. If you analyze two TX channels, these have to be next to each other. The distance between the two TX channels is variable and is defined as a TX offset. The TX channels are labeled C0 and Cu0 in the diagram.

In case of two TX channels, the lower adjacent channels (cl1 and cl2) are to the left of the first TX channel. The upper adjacent channels (cu1 and cu2) are to the right of the second TX channel.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel and adjacent bandwidths. On the y-axis, the power is plotted in dBm.

By default the ACLR settings are based on the selected LTE Channel Bandwidth. You can change the assumed adjacent channel carrier type and the "Noise Correction" on page 59.



The power for the TX channel is an absolute value in dBm. The power of the adjacent channels are values relative to the power of the TX channel.

In case of two TX channels, the power of the adjacent channels to the left of the TX channels are values relative to the power of the left TX channel. The power of the adjacent channels on the right of the TX channels are values relative to the power of the right TX channel.

In addition, the ACLR measurement results are also tested against the limits defined by 3GPP. In the diagram, the limits are represented by horizontal red lines.

ACLR table

A table above the result display contains information about the measurement in numerical form:

- **Channel**
  Shows the channel type (TX, Adjacent or Alternate Channel).
  Note that if you perform a measurement on two TX channels, each TX channel only has one set of adjacent channels. The first TX channel (C0) those to its left, the second TX channel (Cu0) those to its right.
- **Bandwidth**
  Shows the bandwidth of the channel.

- **Spacing**
  Shows the channel spacing.
- **Lower / Upper**
  Shows the relative power of the lower and upper adjacent and alternate channels
- **Limit**
  Shows the limit of that channel, if one is defined.

Remote command:
Selection:
CALCulate<n>:FEED 'SPEC:ACP'
Reading results:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?`
on page 118
TRACe:DATA?

4.4.2 I/Q Measurements

- Power (Spec | RB RS | RB PDSCH).....41
- Flatness (Flat | Grdel | Diff).....43

4.4.2.1 Power (Spec | RB RS | RB PDSCH)

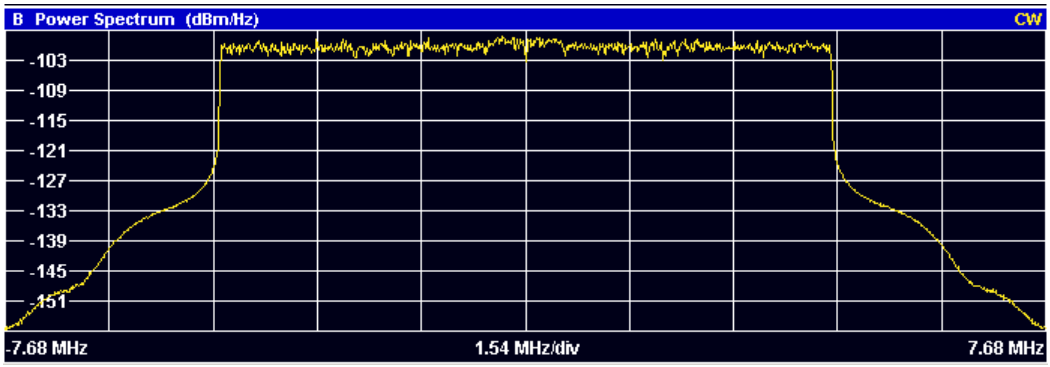
The Power (Spec | RB RS | RB PDSCH) softkey selects one of three result displays. The currently selected result display is highlighted.

Power Spectrum
Starts the Power Spectrum result display.

This result display shows the power density of the complete capture buffer in dBm/Hz. The displayed bandwidth depends on bandwidth or number of resource blocks you have set.

For more information see "Channel Bandwidth / Number of Resource Blocks" on page 50.

The x-axis represents the frequency. On the y-axis the power level is plotted.



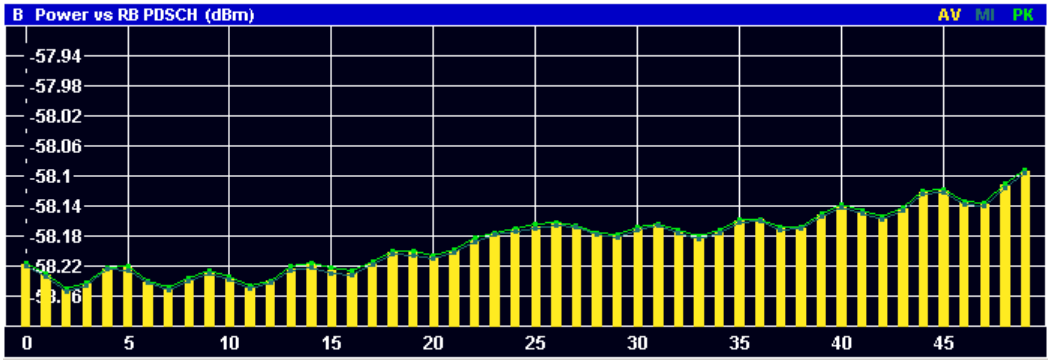
Remote command:
CALCulate<screenid>:FEED 'SPEC:PSPE'
TRACe:DATA?

Power vs Resource Block PDSCH
Starts the Power vs Resource Block PDSCH result display.

This result display shows the power of the physical downlink shared channel per resource block.

By default, three traces are shown. One trace shows the average power. The second and the third trace show the minimum and maximum powers respectively. You can select to display the power for a specific subframe in the Subframe Selection dialog box. In that case, the application shows the powers of that subframe only.

The x-axis represents the resource blocks. The displayed number of resource blocks depends on the channel bandwidth or number of resource blocks you have set. On the y-axis, the power is plotted in dBm.



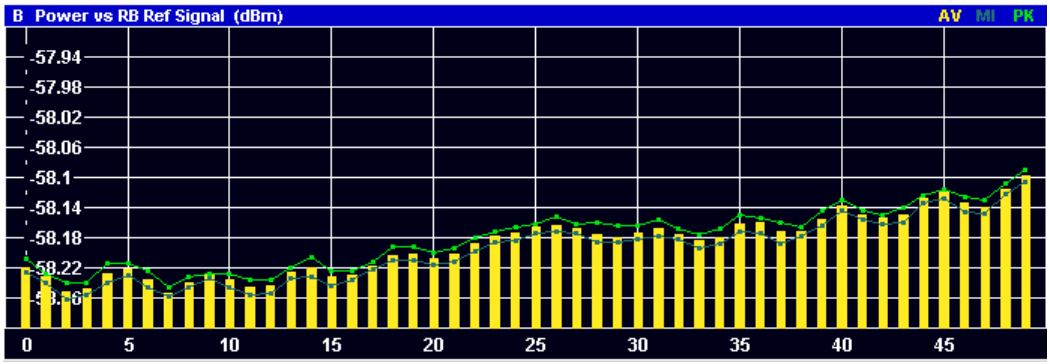
Remote command:
CALCulate<n>:FEED 'SPEC:PVRP'
TRACe:DATA?

Power vs Resource Block RS
Starts the Power vs Resource Block RS result display.

This result display shows the power of the reference signal per resource block.

By default, three traces are shown. One trace shows the average power. The second and the third trace show the minimum and maximum powers respectively. You can select to display the power for a specific subframe in the Subframe Selection dialog box. In that case, the application shows the power of that subframe only.

The x-axis represents the resource blocks. The displayed number of resource blocks depends on the channel bandwidth or number of resource blocks you have set. On the y-axis, the power is plotted in dBm.



Remote command:
CALCulate<n>:FEED 'SPEC:PVRR'
TRACe:DATA?

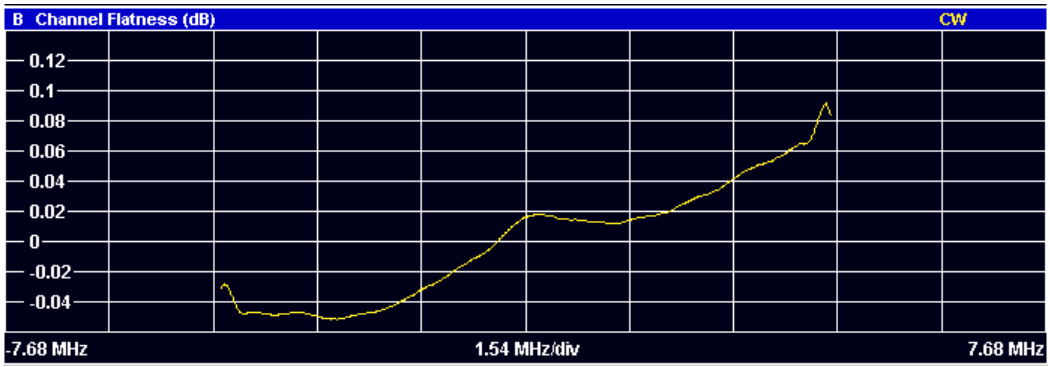
4.4.2.2 Flatness (Flat | Grdel | Diff)

Channel Flatness
Starts the Channel Flatness result display.

This result display shows the relative power offset caused by the transmit channel.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the channel flatness is plotted in dB.



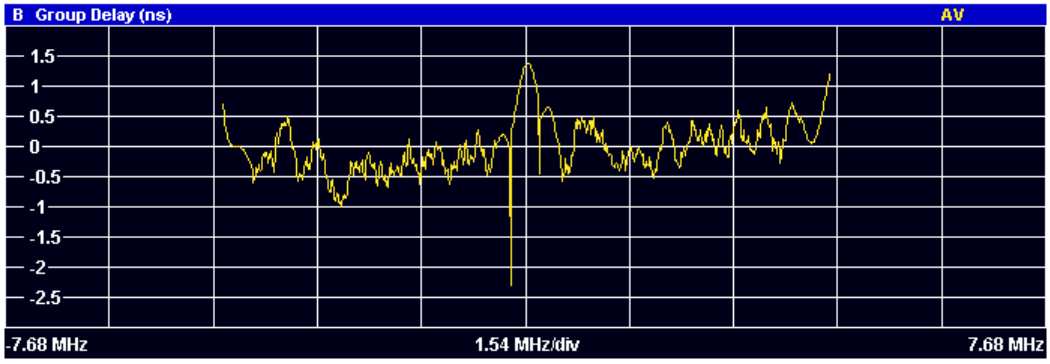
Remote command:
CALCulate<n>:FEED 'SPEC:FLAT'
TRACe:DATA?

Channel Group Delay
Starts the Channel Group Delay result display.

This result display shows the group delay of each subcarrier.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the group delay is plotted in ns.



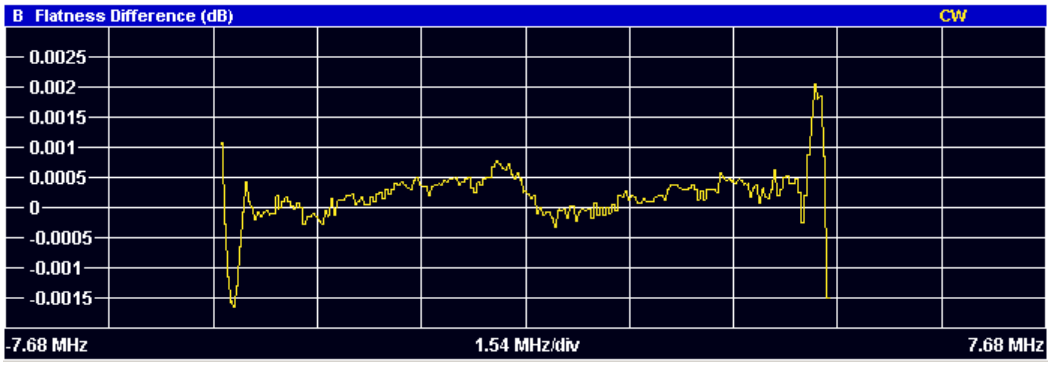
Remote command:
CALCulate<n>:FEED 'SPEC:GDEL'
TRACe:DATA?

Channel Flatness Difference
Starts the Channel Flatness Difference result display.

This result display shows the level difference in the spectrum flatness result between two adjacent physical subcarriers.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the power is plotted in dB.



Remote command:
CALCulate<n>:FEED 'SPEC:FDIF'
TRACe:DATA?

4.5 Measuring the Symbol Constellation

This chapter contains information on all measurements that show the constellation of a signal.

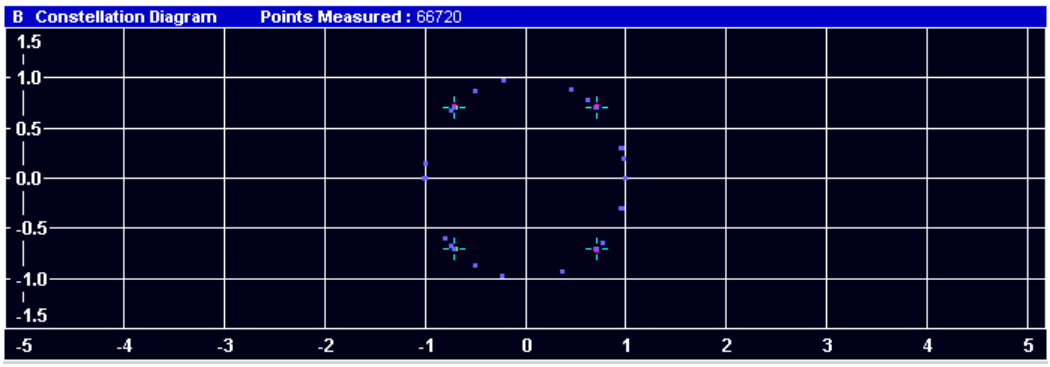
Constellation Diagram.....45

Constellation Diagram
Starts the Constellation Diagram result display.

This result display shows the inphase and quadrature phase results and is an indicator of the quality of the modulation of the signal.

In the default state, the result display evaluates the full range of the measured input data. You can filter the results in the Constellation Selection dialog box.

The ideal points for the selected modulation scheme are displayed for reference purposes.



The constellation diagram also contains information about the current evaluation range. In addition, it shows the number of points that are displayed in the diagram.

Remote command:
CALCulate<n>:FEED 'CONS:CONS'
TRACe:DATA?

4.6 Measuring Statistics

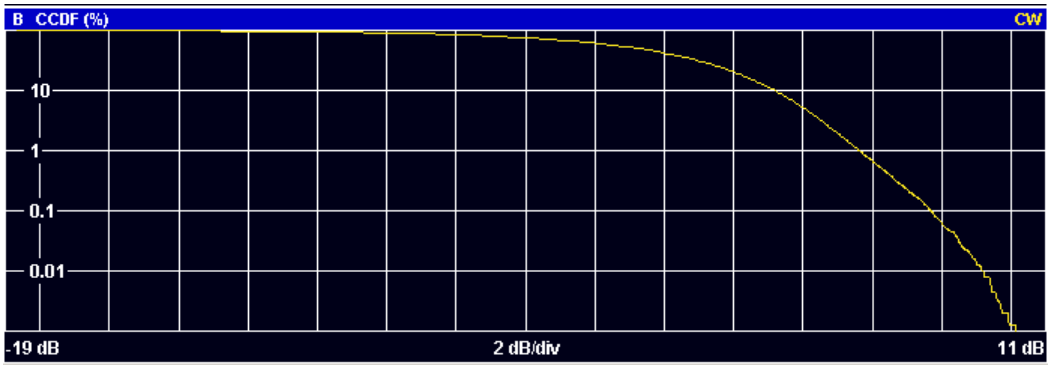
This chapter contains information on all measurements that show the statistics of a signal.

CCDF....45
Allocation Summary....46
Bit Stream....47

CCDF
Starts the Complementary Cumulative Distribution Function (CCDF) result display.

This result display shows the probability of an amplitude exceeding the mean power. For the measurement, the complete capture buffer is used.

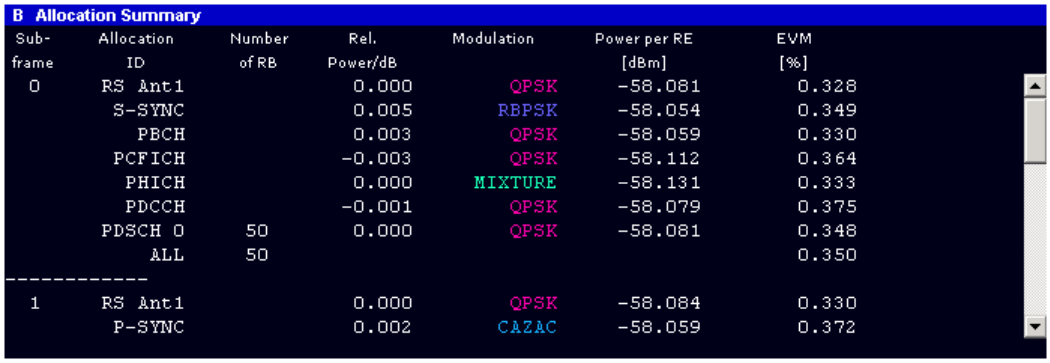
The x-axis represents the power relative to the measured mean power. On the y-axis, the probability is plotted in %.



Remote command:
CALCulate<n>:FEED 'STAT:CCDF'
TRACe:DATA?

Allocation Summary
Starts the Allocation Summary result display.

This result display shows the results of the measured allocations in tabular form.


B Allocation Summary
Sub-frame | Allocation ID | Number of RB | Rel. Power/dB | Modulation | Power per RE [dBm] | EVM [%]
0 | RS Ant1 | | 0.000 | QPSK | -58.081 | 0.328
S-SYNC | | 0.005 | RBPSK | -58.054 | 0.349
PBCH | | 0.003 | QPSK | -58.059 | 0.330
PCFICH | | -0.003 | QPSK | -58.112 | 0.364
PHICH | | 0.000 | MIXTURE | -58.131 | 0.333
PDCCH | | -0.001 | QPSK | -58.079 | 0.375
PDSCH 0 | 50 | 0.000 | QPSK | -58.081 | 0.348
ALL | 50 | | | | 0.350
1 | RS Ant1 | | 0.000 | QPSK | -58.084 | 0.330
P-SYNC | | 0.002 | CAZAC | -58.059 | 0.372

The rows in the table represent the allocations, with allocation ALL being a special allocation that summarizes all allocations that are part of the subframe. A set of allocations form a subframe. The subframes are separated by a dashed line. The columns of the table contain the following information:

The rows in the table represent the allocations. A set of allocations form a subframe. The subframes are separated by a dashed line. The columns of the table contain the follwing information:

- **Subframe**
  Shows the subframe number.
- **Allocation ID**
  Shows the type / ID of the allocation.
- **Number of RB**
  Shows the number of resource blocks assigned to the current PDSCH allocation.
- **Rel. Power/dB**
  Shows the relative power of the allocation.
- **Modulation**
  Shows the modulation type.
- **Power per RE [dBm]**
  Shows the power of each resource element in dBm.

- **EVM**
  Shows the EVM of the allocation. The unit depends on your selection.

Remote command:
CALCulate<n>:FEED 'STAT:ASUM'
TRACe:DATA?

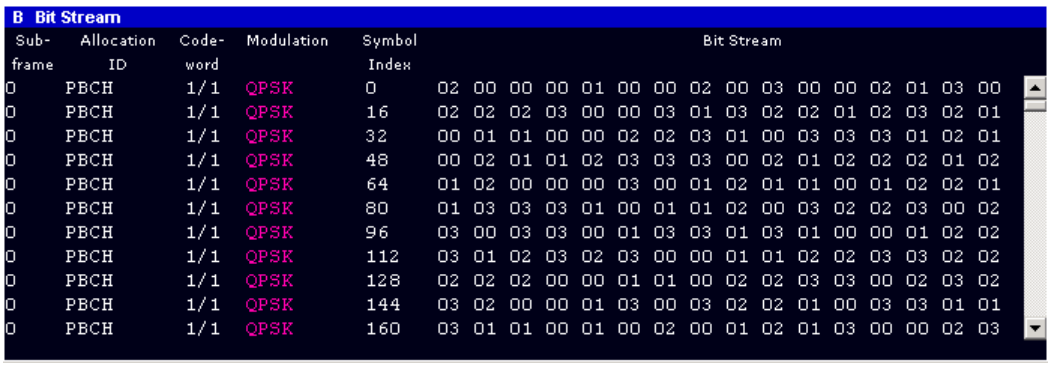
Bit Stream
Starts the Bit Stream result display.

This result display shows the demodulated data stream for each data allocation. Depending on the Bit Stream Format, the numbers represent either bits (bit order) or symbols (symbol order).

Selecting symbol format shows the bit stream as symbols. In that case the bits belonging to one symbol are shown as hexadecimal numbers with two digits. In the case of bit format, each number represents one raw bit.

Symbols or bits that are not transmitted are represented by a "-".

If a symbol could not be decoded because the number of layers exceeds the number of receive antennas, the application shows a "#" sign.



The table contains the following information:

- **Subframe**
  Number of the subframe the bits belong to.
- **Allocation ID**
  Channel the bits belong to.
- **Codeword**
  Code word of the allocation.
- **Modulation**
  Modulation type of the channels.
- **Bit / Symbol Index**
  Shows the position of the table row's first bit or symbol within the complete stream.
- **Bit Stream**
  The actual bit stream.

Remote command:
CALCulate<n>:FEED 'STAT:BSTR'
TRACe:DATA?

5 Configuring and Performing the Measurement

Before you can start a measurement, you have to configure the R&S FSV in order to get valid measurement results. This chapter contains detailed information on all settings available in the application.

You can access the two main settings dialog boxes via the "Settings (Gen Demod)" softkey. Pressing the softkey once opens the "General Settings" dialog box. The "Gen" label in the softkey turns orange to indicate an active "General Settings" dialog box. Pressing the softkey again opens the "Demod Settings" dialog box. When the "Demod Settings" dialog box is active, the "Demod" label in the softkey turns orange.

In the "General Settings" dialog box, you can set all parameters that are related to the overall measurement. The dialog box is made up of three tabs, one for general settings, one for MIMO settings and one for advanced settings. By default, the "General" tab is the active one.

In the "Demod Settings" dialog box you can set up the measurement in detail, e.g. the demodulation configuration. The dialog box is made up of three tabs, one for configuring the signal configuration, one for setting up the frame configuration and one for configuring the control channels and miscellaneous settings. By default, the "DL Demod" tab is the active one.

You can switch between the tabs by touching the tab on the touchscreen or with the cursor keys.

- Performing Measurements....48
- General Settings....49
- Configuring MIMO Setups....56
- Configuring Spectrum Measurements....57
- Advanced General Settings....59
- Configuring Downlink Signal Demodulation....61
- Configuring Downlink Frames....66
- Defining Advanced Signal Characteristics....71

5.1 Performing Measurements

The sweep menu contains functions that control the way the R&S FSV performs a measurement.

Single Sweep and Continuous Sweep
In continuous sweep mode, the R&S FSV continuously captures data, performs measurements and updates the result display according to the trigger settings.

To activate single sweep mode, press the "Run Single" softkey. In single sweep mode, the R&S FSV captures data, performs the measurement and updates the result display exactly once after the trigger event. After this process, the R&S FSV interrupts the measurement.

You can always switch back to continuous sweep mode with the "Run Cont" softkey.

Remote command:
`INITiate:CONTinuous` on page 96

Auto Level
The "Auto Level" softkey initiates a process that sets an ideal reference level for the current measurement.

For more information see "Defining a Reference Level" on page 52.

Remote command:
`[SENSe]:POWer:AUTO<analyzer>[:STATe]` on page 123

Refresh
Updates the current result display in single sweep mode without capturing I/Q data again.

If you have changed any settings after a single sweep and use the Refresh function, the R&S FSV updates the current measurement results with respect to the new settings. It does not capture I/Q data again but uses the data captured last.

Remote command:
`INITiate:REFResh` on page 97

Adjust Timing
Adjusts the timing when you perform Transmit On/Off Power measurements.

For more information see "Performing the measurement" on page 26.

Adjust timing is available for measurements with an external trigger.

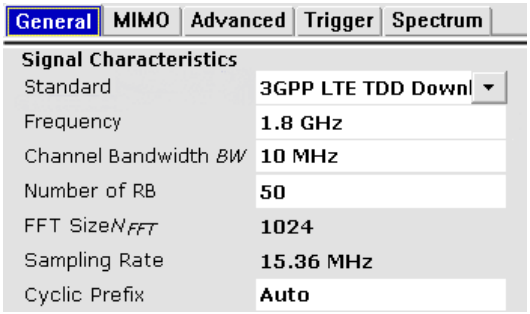
Remote command:
`[SENSe][:LTE]:OOPower:ATIMing` on page 97

5.2 General Settings

5.2.1 Defining Signal Characteristics

The general signal characteristics contain settings to describe the general physical attributes of the signal.

The signal characteristics are part of the "General" tab of the "General Settings" dialog box.



Selecting the LTE Mode....50
Defining the Signal Frequency....50
Channel Bandwidth / Number of Resource Blocks....50
Cyclic Prefix....51

Selecting the LTE Mode

The standard defines the LTE mode you are testing.

The choices you have depend on the configuration of the R&S FSV.

- option FSx-K100(PC) enables testing of 3GPP LTE FDD signals on the downlink
- option FSx-K101(PC) enables testing of 3GPP LTE FDD signals on the uplink
- option FSx-K102(PC) enables testing of 3GPP LTE MIMO signals on the downlink
- option FSx-K104(PC) enables testing of 3GPP LTE TDD signals on the downlink
- option FSx-K105(PC) enables testing of 3GPP LTE TDD signals on the uplink

FDD and TDD are **duplexing** methods.

- FDD mode uses different frequencies for the uplink and the downlink.
- TDD mode uses the same frequency for the uplink and the downlink.

Downlink (DL) and Uplink (UL) describe the **transmission path**.

- Downlink is the transmission path from the base station to the user equipment. The physical layer mode for the downlink is always OFDMA.
- Uplink is the transmission path from the user equipment to the base station. The physical layer mode for the uplink is always SC-FDMA.

Remote command:

`CONFigure[:LTE]:LDIRection` on page 120

`CONFigure[:LTE]:DUPLexing` on page 120

Defining the Signal Frequency

For measurements with an RF input source, you have to match the **center frequency** of the analyzer to the frequency of the signal.

The available frequency range depends on the hardware configuration of the analyzer you are using.

The frequency setting is available for the RF input source.

Remote command:

Center frequency:

`[SENSe]:FREQuency:CENTer` on page 121

Channel Bandwidth / Number of Resource Blocks

Specifies the channel bandwidth and number of resource blocks (RB).

The channel bandwidth and number of resource blocks (RB) are interdependent. Currently, the LTE standard recommends six bandwidths (see table below).

The R&S FSV also calculates the FFT size and sampling rate from the channel bandwidth. Those are read only.

Channel Bandwidth [MHz]	1.4	3	5	10	15	20
Number of Resource Blocks	6	15	25	50	75	100
Sample Rate [MHz]	1.92	3.84	7.68	15.36	30.72	30.72
FFT Size	128	256	512	1024	2048	2048

Remote command:
`CONFigure[:LTE]:DL:BW` on page 119
`CONFigure[:LTE]:DL:NORB` on page 120

Cyclic Prefix
The cyclic prefix serves as a guard interval between OFDM symbols to avoid interferences. The standard specifies two cyclic prefix modes with a different length each.

The cyclic prefix mode defines the number of OFDM symbols in a slot.

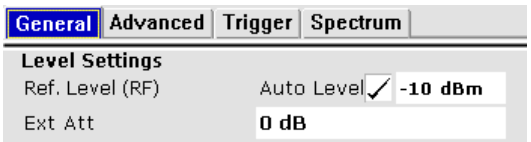
- Normal
  A slot contains 7 OFDM symbols.
- Extended
  A slot contains 6 OFDM symbols.
  The extended cyclic prefix is able to cover larger cell sizes with higher delay spread of the radio channel.
- Auto
  The application automatically detects the cyclic prefix mode in use.

Remote command:
`CONFigure[:LTE]:DL:CYCPrefix` on page 119

5.2.2 Configuring the Input Level

The level settings contain settings that control the input level of the analyzer.

The level settings are part of the "General" tab of the "General Settings" dialog box.



Defining a Reference Level....52
Attenuating the Signal....52

Defining a Reference Level

The reference level is the power level the R&S FSV expects at the RF input. Keep in mind that the power level at the RF input is the peak envelope power in case of signals with a high crest factor like LTE.

To get the best dynamic range, you have to set the reference level as low as possible. At the same time, make sure that the maximum signal level does not exceed the reference level. If it does, it will overload the A/D converter, regardless of the signal power. Measurement results may deteriorate (e.g. EVM). This applies especially for measurements with more than one active channel near the one you are trying to measure (± 6 MHz).

Note that the signal level at the A/D converter may be stronger than the level the application displays, depending on the current resolution bandwidth. This is because the resolution bandwidths are implemented digitally after the A/D converter.

You can either specify the **RF Reference Level** (in dBm) or **Baseband Reference Level** (in V), depending on the input source.

You can also use **automatic detection** of the reference level with the "Auto Level" function.

If active, the application measures and sets the reference level to its ideal value before each sweep. This process slightly increases the measurement time. You can define the measurement time of that measurement with the **Auto Level Track Time**.

Automatic level detection also optimizes RF attenuation.

Remote command:
Manual (RF):
`CONFigure:POWer:EXPected:RF<analyzer>` on page 122
Manual (BB):
`CONFigure:POWer:EXPected:IQ<analyzer>` on page 121
Automatic:
`[SENSe]:POWer:AUTO<analyzer>[:STATe]` on page 123
Auto Level Track Time:
`[SENSe]:POWer:AUTO<analyzer>:TIME` on page 124

Attenuating the Signal

Attenuation of the signal may become necessary if you have to reduce the power of the signal that you have applied. Power reduction is necessary, for example, to prevent an overload of the input mixer.

The LTE application provides several attenuation modes.

- **External** attenuation is always available. It controls an external attenuator if you are using one.
- **Mechanical** (or RF) attenuation is always available. The mechanical attenuator controls attenuation at the RF input.
  Mechanical attenuation is available in the "Advanced" tab of the "General Settings" dialog box.

Positive values correspond to an attenuation and negative values correspond to an amplification.

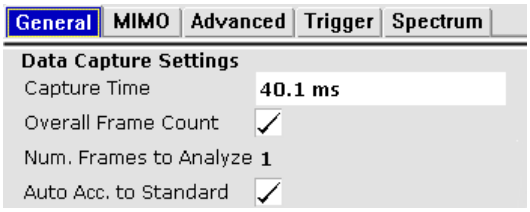
RF attenuation is independent of the reference level. It is available if automatic reference level detection is inactive. The range is from 0 dB to 75 dB.

Remote command:
RF attenuation:
INPut<n>:ATTenuation<analyzer> on page 122
External attenuation:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet on page 122

5.2.3 Configuring the Data Capture

The data capture settings contain settings that control the amount of data and the way that the application records the LTE signal.

The data capture settings are part of the "General" tab of the "General Settings" dialog box.



Capture Time....53
Overall Frame Count....53
Number of Frames to Analyze....54
Auto According to Standard....54

Capture Time
Defines the capture time.

The capture time corresponds to the time of one sweep. Hence, it defines the amount of data the application captures during one sweep.

By default, the application captures 20.1 ms of data to make sure that at least one complete LTE frame is captured in one sweep.

Remote command:
[SENSe]:SWEep:TIME on page 125

Overall Frame Count
Turns the manual selection of the number of frames to capture (and analyze) on and off.

If the overall frame count is active, you can define a particular number of frames to capture and analyze. The measurement runs until all required frames have been analyzed, even if it takes more than one sweep. The results are an average of the captured frames.

If the overall frame count is inactive, the R&S FSV analyzes all complete LTE frames currently in the capture buffer.

Remote command:
[SENSe][:LTE]:FRAMe:COUNt:STATe on page 125

Number of Frames to Analyze
Sets the number of frames that you want to capture and analyze.

If the number of frames you have set last longer than a single sweep, the R&S FSV continues the measurement until all frames have been captured.

The parameter is read only if

- the overall frame count is inactive,
- the data is captured according to the standard.

Remote command:
`[SENSe][:LTE]:FRAMe:COUNt` on page 124

Auto According to Standard
Turns automatic selection of the number of frames to capture and analyze on and off.

If active, the R&S FSV evaluates the number of frames as defined for EVM tests in the LTE standard.

If inactive, you can set the number of frames you want to analyze.

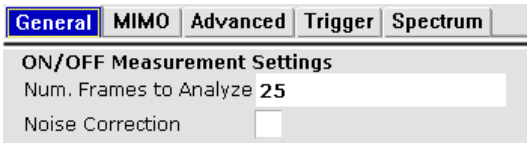
This parameter is not available if the overall frame count is inactive.

Remote command:
`[SENSe][:LTE]:FRAMe:COUNt:AUTO` on page 124

5.2.4 Configuring On/Off Power Measurements

The On/Off power measurement settings define characteristics of On/Off power measurements.

The On/Off measurement settings are part of the "General" tab of the "General Settings" dialog box.



Number of Frames....54
Noise Correction....54

Number of Frames
Defines the number of frames that are averaged to calculate a reliable power trace for On/Off Power measurements.

Remote command:
`CONFigure[:LTE]:OOPower:NFRames` on page 125

Noise Correction
Turns noise correction for On/Off Power measurements on and off.

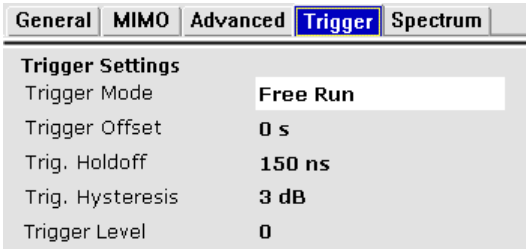
For more information see the manual of the R&S FSV.

Remote command:
`[SENSe][:LTE]:OOPower:NCORrection` on page 125

5.2.5 Triggering Measurements

The trigger settings contain settings that control triggered measurements.

The trigger settings are part of the "Trigger" tab of the "General Settings" dialog box.



For more information also see Auto Gating in the "Spectrum" tab of the "General Settings" dialog box.

Configuring the Trigger.....55

Configuring the Trigger

A trigger allows you to capture those parts of the signal that you are really interested in.

While the R&S FSV runs freely and analyzes all signal data in its default state, no matter if the signal contains information or not, a trigger initiates a measurement only under certain circumstances (the trigger event).

The R&S FSV supports several **trigger modes** or sources.

- Free Run
  Starts the measurement immediately and measures continuously.
- External
  The trigger event is the level of an external trigger signal. The measurement starts when this signal meets or exceeds a specified trigger level at the "Ext Trigger/Gate" input.
- IF Power
  The trigger event is the IF power level. The measurement starts when the IF power meets or exceeds a specified power trigger level.
- RF Power
  The trigger event is the RF power level. The measurement starts when a signal outside of the measured channel meets or exceeds a certain level at the first intermediate frequency.
  The level range is from -50 dBm to -10 dBm. The corresponding trigger level at the RF input is:
  The RF Power trigger is available with detector board 1307.9554.02 Rev. 05.00 or higher. It is not available for measurements with the digital I/Q interface (R&S FSV-B17).
- Power Sensor
  The trigger event is a specified level measured by a power sensor. The measurement starts when a power sensor measurement meets certain conditions.
  The power sensor as a trigger source is available with option R&S FSV-K9 and a connected power sensor.

You can define a **power level** for an external, IF power, RF power or power sensor trigger.

The name and contents of the Power Level field depend on the selected trigger mode. It is available only in combination with the corresponding trigger mode.

The measurement starts as soon as the trigger event happens. It may become necessary to start the measurement some time after the trigger event. In that case, define a **trigger offset** (or trigger delay). The trigger offset is the time that should pass between the trigger event and the start of the measurement.

The trigger offset may be a negative time. The trigger offset is then called a **pretrigger**.

The trigger offset is available for all trigger modes, except free run.

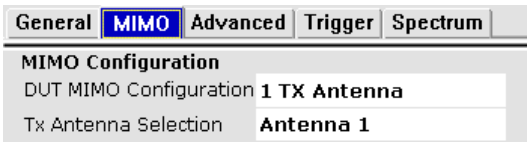
A trigger event usually is a certain level value. The **trigger hysteresis** defines a distance to the trigger level that the input signal must stay below in order to fulfill the trigger condition.

If you want to have a minimum time between indivudual measurements, set a **trigger holdoff**. A trigger holdoff defines a waiting period that must at least pass between one trigger event and the next.

Remote command:
For a comprehensive list of commands to define trigger characteristics see chapter 8.7.1.5, "Triggering Measurements", on page 126.

5.3 Configuring MIMO Setups

The MIMO Configuration contains settings to configure MIMO test setups.



MIMO Configuration.....56

MIMO Configuration
Selects the antenna configuration and test conditions for a MIMO system.

The MIMO **configuration** selects the number of transmit antennas in the system. 1-, 2-, and 4-antenna configurations are possible.

In setups with multiple antennas, **antenna selection** defines the antenna you'd like to test. You can select the antenna(s) to test manually. Note that the selected antenna is also the reference antenna for Time Alignment measurements.

Antenna 1	Tests antenna 1 only.
Antenna 2	Tests antenna 2 only.

Antenna 3	Tests antenna 3 only.
Antenna 4	Tests antenna 4 only.

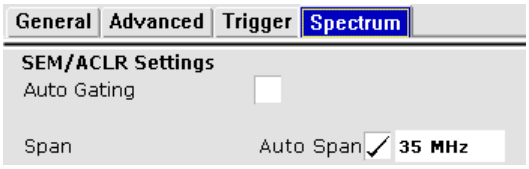
Remote command:
MIMO configuration
`CONFigure[:LTE]:DL:MIMO:CONFig` on page 128
Antenna selection:
`CONFigure[:LTE]:DL:MIMO:ASELection` on page 127

5.4 Configuring Spectrum Measurements

The Spectrum settings contain parameters to configure spectrum measurements (ACLR and SEM) in particular.

5.4.1 General ACLR and SEM Configuration

The gate settings settings are part of the "Spectrum" tab of the "General Settings" dialog box.



Auto Gating....57
Span....57

Auto Gating
Turns gating for SEM and ACLR measurements on and off.

If on, the software evaluates the on-periods of an LTE TDD signal only. The software determines the location and length of the on-period from the "TDD UL/DL Allocations" and the "Configuration of the Special Subframe".

Auto gating is available for TDD measurements in combination with an external or IF power trigger.

If you are using an external trigger, the DUT has to send an LTE frame trigger.

Remote command:
`[SENSe]:SWEep:EGATe:AUTO` on page 95

Span
Defines the frequency span that is displayed in the frequency sweep result displays (SEM and ACLR).

When the "Auto Span" is on, the application automatically calculates the ideal span for the measured signal. The ideal span for the signal depends on the channel bandwidth that you have selected.

Alternatively, you can define the span manually when you turn the "Auto Span" off. When you define the span manually, you can enter any number that is greater than the span that would be calculated automatically. This mechanism makes sure that the span is not too small for the signal bandwidth and the complete signal is displayed.

Nopte that changing the span only takes effect when you start a new measurement after you have changed the span.

5.4.2 Configuring SEM Measurements

The SEM settings are part of the "Spectrum" tab of the "General Settings" dialog box.

Category....58

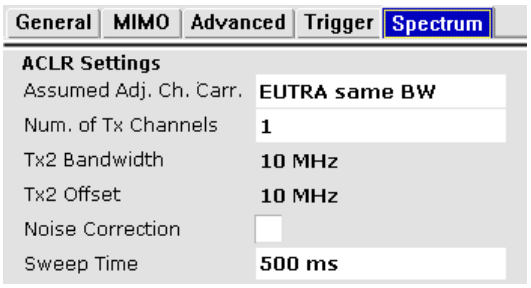
Category
Selects the limit definitions for SEM measurements.

Category A and B are defined in ITU-R recommendation SM.329. The category you should use for the measurement depends on the category that the base station you are testing supports.

Remote command:
`[SENSe]:POWer:SEM:CATegory` on page 95

5.4.3 Configuring ACLR Measurements

The ACLR settings are part of the "Spectrum" tab of the "General Settings" dialog box.



Assumed Adjacent Channel Carrier....58
Noise Correction....59
Sweep Time....59
Number of TX Channels....59

Assumed Adjacent Channel Carrier
Selects the assumed adjacent channel carrier for the ACLR measurement.

The supported types are EUTRA of same bandwidth, 1.28 Mcps UTRA, 3.84 Mcps UTRA and 7.68 Mcps UTRA.

Note that not all combinations of LTE Channel Bandwidth settings and Assumed Adj. Channel Carrier settings are defined in the 3GPP standard.

Remote command:
[SENSe]:POWer:ACHannel:AACHannel on page 93

Noise Correction
Turns noise correction on and off.

For more information see the manual of the R&S FSV.

Note that the input attenuator makes a clicking noise after each sweep if you are using the noise correction in combination with the auto leveling process.

Remote command:
[SENSe]:POWer:NCORrection on page 95

Sweep Time
Defines a sweep time for ACLR measurements.

A longer sweep time may increase the probability that the measured value converges to the true value of the adjacent channel power, but obviously increases measurement time.

Number of TX Channels
Defines the number of transmission (TX) channels to include in ACLR measurements.

Measurements on one or two TX channels are supported. For measurements on two TX channels, you can additionally define the bandwidth of the second TX channel and the distance between the two TX channels.

For the second TX channel, you can select the bandwidths as defined by 3GPP. For more information see "Channel Bandwidth / Number of Resource Blocks" on page 50.

Remote command:
[SENSe]:POWer:ACHannel:BANDwidth:CHANnel2 on page 94
[SENSe]:POWer:ACHannel:SPACing:CHANnel on page 94
[SENSe]:POWer:ACHannel:TXCHannels:COUNt on page 94

5.5 Advanced General Settings

The "Advanced" settings contain parameters to configure more complex measurement setups.

5.5.1 Controlling I/Q Data

The I/Q settings contain settings that control the I/Q data flow.

The I/Q settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.

Swap I/Q.....60

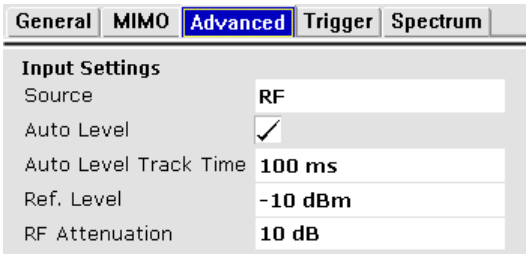
Swap I/Q
Swaps the real (I branch) and the imaginary (Q branch) parts of the signal.

Remote command:
`[SENSe]:SWAPiq` on page 128

5.5.2 Controlling the Input

The input settings contain settings that control the input source.

The input settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.



For more information on reference level see "Defining a Reference Level" on page 52.

For more information on signal attenuation see "Attenuating the Signal" on page 52.

Selecting the Input Source.....60

Selecting the Input Source
The input source selects the source of the data you'd like to analyze. You can either analyze a live signal or a signal that has been recorded previously and whose characteristics have been saved to a file.

You can select the input source from the "Source" dropdown menu.

- RF
  Captures and analyzes the data from the RF input of the spectrum analyzer in use.
- Baseband (BB)
  Captures and analyzes the data from the baseband input of the spectrum analyzer in use.
- Digital I/Q
  Captures and analyzes the data from the digital baseband input of the spectrum analyzer in use.
  The digital baseband input is available with option R&S FSV-B17.

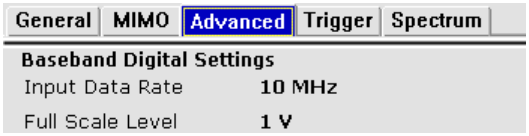
For more information on using hardware option R&S FSV-B17 see the manual of the R&S FSV.

Remote command:
`INPut:SELect` on page 128

5.5.3 Configuring the Digital I/Q Input

The digital I/Q settings contain settings that configure the digital I/Q input.

The digital I/Q settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.



Sampling Rate (Input Data Rate).....61
Full Scale Level.....61

Sampling Rate (Input Data Rate)
Defines the data sample rate at the digital baseband input.

The sample rate is available for a digital baseband input source.

Remote command:
`INPut<n>:DIQ:SRATe` on page 129

Full Scale Level
Defines the voltage corresponding to the maximum input value of the digital baseband input.

Remote command:
`INPut<n>:DIQ:RANGe[:UPPer]` on page 129

5.6 Configuring Downlink Signal Demodulation

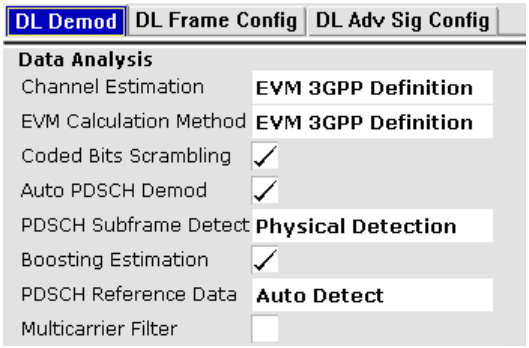
The downlink demodulation settings contain settings that describe the signal processing and the way the signal is measured.

You can find the demodulation settings in the "Demod Settings" dialog box.

5.6.1 Configuring the Data Analysis

The data analysis settings contain settings that determine the way the captured signal is analyzed.

The data analysis settings are part of the "Downlink Demod" tab of the "Demodulation Settings" dialog box.



Channel Estimation....62
EVM Calculation Method....62
Scrambling of Coded Bits....62
Auto PDSCH Demodulation....63
PDSCH Subframe Configuration Detection....63
Boosting Estimation....64
PDSCH Reference Data....64
Multicarrier Filter....64

Channel Estimation
Selects the method of channel estimation.

- **EVM 3GPP Definition**
  Channel estimation according to 3GPP TS 36.141. This method is based on averaging in frequency direction and linear interpolation. Examines the reference signal only.
- **Optimal, Pilot only**
  Optimal channel estimation method. Examines the reference signal only.
- **Optimal, Pilot and Payload**
  Optimal channel estimation method. Examines both the reference signal and the payload resource elements.

Remote command:
`[SENSe][:LTE]:DL:DEMod:CESTimation` on page 131

EVM Calculation Method
Selects the method to calculate the EVM.

- **EVM 3GPP Definition**
  Calculation of the EVM according to 3GPP TS 36.141. Evaluates the EVM at two trial timing positions and then uses the maximum EVM of the two.
- **At Optimal Timing Position**
  Calculates the EVM using the optimal timing position.

Remote command:
`[SENSe][:LTE]:DL:DEMod:EVMCalc` on page 131

Scrambling of Coded Bits
Turns the scrambling of coded bits for all physical channels like PDSCH or PHICH on and off.

The scrambling of coded bits affects the bitstream results.

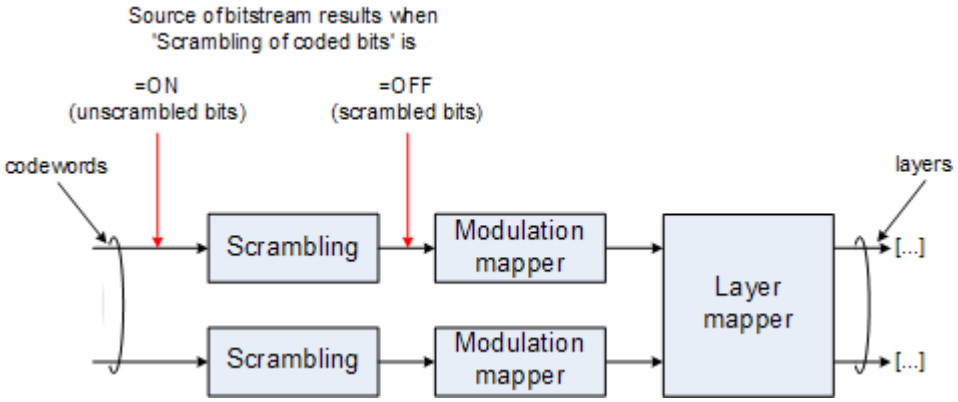


Fig. 5-1: Source for bitstream results if scrambling for coded bits is on and off

Remote command:
`[SENSe][:LTE]:DL:DEMod:CBSCrambling` on page 131

Auto PDSCH Demodulation
Turns automatic demodulation of the PDSCH on and off.

Turn on automatic PDSCH demodulation for automatic detection of the PDSCH resource allocation. The application is able to detect the PDSCH resource allocation by analyzing the protocol information in the PDCCH or by analyzing the physical signal. It then writes the results into the PDSCH Configuration Table.

You can set the way the R&S FSV identifies the PDSCH resource allocation with "PDSCH Subframe Configuration Detection" on page 63.

If the automatic demodulation of the PDSCH is off, you have to configure the PDSCH manually. In that case, the application compares the demodulated LTE frame to the customized configuration. If the PDSCH Subframe Configuration Detection is not turned off, the application analyzes the frame only if both configurations are the same.

Remote command:
`[SENSe][:LTE]:DL:DEMod:AUTO` on page 130

PDSCH Subframe Configuration Detection
Selects the method of identifying the PDSCH resource allocation.

- Off
  Uses the user configuration to demodulate the PDSCH subframe. If the user configuration does not match the frame that was measured, a bad EVM will result.
- PDCCH protocol
  Sets the PDSCH configuration according to the data in the protocol of the PDCCH DCIs.
- Physical detection
  The physical detection is based on power and modulation detection.
  Physical detection makes measurements on TDD E-TMs without a 20 ms trigger signal possible.

For more information on automatic demodulation see "Auto PDSCH Demodulation" on page 63.

Remote command:
[SENSe][:LTE]:DL:FORMat:PSCD on page 132

Boosting Estimation
Turns boosting estimation on and off.

If active, the R&S FSV automatically sets the relative power settings of all physical channels and the P-/S-SYNC by analyzing the signal.

Remote command:
[SENSe][:LTE]:DL:DEMod:BESTimation on page 130

PDSCH Reference Data
Selects the type of reference data to calculate the EVM for the PDSCH.

- Auto detect
  Automatically identifies the reference data for the PDSCH by analyzing the signal.
- All 0 (E-TM)
  Sets the PDSCH reference data to a fixed value of 0. This value is according to the test model definition.
  To get valid results, you have to use a DUT that transmits an all-zero data vector.
  This setting is a good way if you are expecting signals with a high EVM because the automatic detection will not be reliable in that case.

Remote command:
[SENSe][:LTE]:DL:DEMod:PRData on page 132

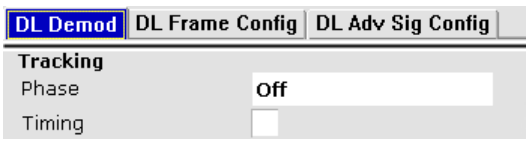
Multicarrier Filter
Turns the suppression of interference of neighboring carriers for tests on multiradio base stations on and off (e.g. LTE, WCDMA, GSM etc).

Remote command:
[SENSe][:LTE]:DL:DEMod:MCFilter on page 131

5.6.2 Compensating Measurement Errors

The tracking settings contain settings that compensate for various common measurement errors that may occur.

The tracking settings are part of the "Downlink Demod" tab of the "Demodulation Settings" dialog box.



Phase....65
Timing....65

Phase
Specifies whether or not the measurement results should be compensated for common phase error. When phase compensation is used, the measurement results will be compensated for phase error on a per-symbol basis.

"Off"	Phase tracking is not applied.
"Pilot Only"	Only the reference signal is used for the estimation of the phase error.
"Pilot and Payload"	Both reference signal and payload resource elements are used for the estimation of the phase error.

Remote command:
`[SENSe][:LTE]:DL:TRACking:PHASe` on page 133

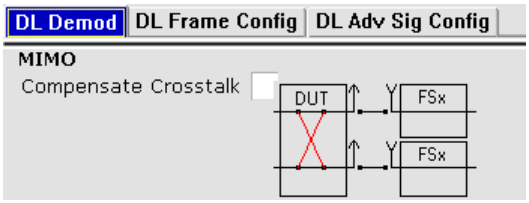
Timing
Specifies whether or not the measurement results should be compensated for timing error. When timing compensation is used, the measurement results will be compensated for timing error on a per-symbol basis.

Remote command:
`[SENSe][:LTE]:DL:TRACking:TIME` on page 133

5.6.3 Configuring MIMO Setups

The MIMO settings contain settings that configure MIMO measurement setups.

The MIMO settings are part of the "Downlink Demod" tab of the "Demodulation Settings" dialog box.



Compensate Crosstalk.....65

Compensate Crosstalk
Specifies if crosstalk produced by the device under test or over-the-air measurements will be compensated or not.

The crosstalk compensation must be activated for Time Alignment Error measurements.For more information see chapter 3.4, "Performing Time Alignment Measurements", on page 23.

Remote command:
`CONFigure[:LTE]:DL:MIMO:CROSstalk` on page 133

5.7 Configuring Downlink Frames

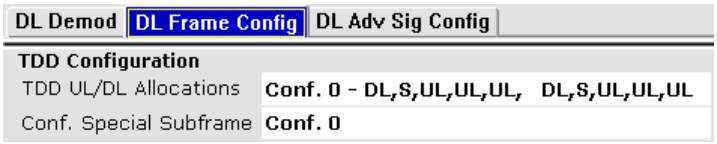
The frame configuration contains settings that define the structure of the downlink LTE signal.

You can find the frame structure in the "Demod Settings" dialog box.

5.7.1 Configuring TDD Signals

The TDD settings define the characteristics of an LTE TDD signal.

The TDD settings are part of the "Frame Configuration" tab of the "Demodulation Settings" dialog box.



Configuring TDD Frames.....66

Configuring TDD Frames
TDD frames contain both uplink and downlink information separated in time with every subframe being responsible for either uplink or downlink transmission. The standard specifies several subframe configurations or resource allocations for TDD systems.

TDD UL/DL Allocations

Selects the configuration of the subframes in a radio frame in TDD systems.

The UL/DL configuration (or allocation) defines the way each subframe is used: for uplink, downlink or if it is a special subframe. The standard specifies seven different configurations.

Configuration	Subframe Number and Usage									
	0	1	2	3	4	5	6	7	8	9
0	D	S	U	U	U	D	S	U	U	U
1	D	S	U	U	D	D	S	U	U	D
2	D	S	U	D	D	D	S	U	D	D
3	D	S	U	U	U	D	D	D	D	D
4	D	S	U	U	D	D	D	D	D	D
5	D	S	U	D	D	D	D	D	D	D
6	D	S	U	U	U	D	S	U	U	D

U = uplink
D = downlink
S = special subframe

Conf. of Special Subframe

In combination with the cyclic prefix, the special subframes serve as guard periods for switches from uplink to downlink. They contain three parts or fields.

- DwPTS

The DwPTS is the downlink part of the special subframe. It is used to transmit downlink data.

- GP
  The guard period makes sure that there are no overlaps of up- and downlink signals during a switch.
- UpPTS
  The UpPTS is the uplink part of the special subframe. It is used to transmit uplink data.

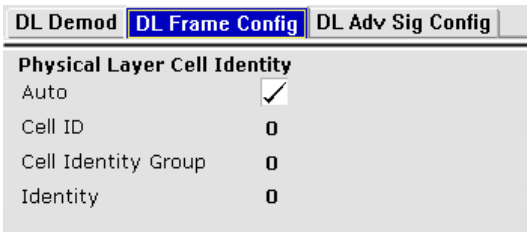
The length of the three fields is variable. This results in several possible configurations of the special subframe. The LTE standard defines 9 different configurations for the special subframe. However, configurations 7 and 8 only work for a normal cyclic prefix. If you select it using an extended cyclic prefix or automatic detection of the cyclic prefix, the application will show an error message.

Remote command:
Subframe
`CONFigure[:LTE]:DL:TDD:UDConf` on page 134
Special Subframe
`CONFigure[:LTE]:DL:TDD:SPSC` on page 134

5.7.2 Configuring the Physical Layer Cell Identity

The physical signal characteristics contain settings to describe the phyiscal attributes of an LTE signal.

The physical settings are part of the "Frame Configuration" tab of the "Demodulation Settings" dialog box.



Configuring the Physical Layer Cell Identity.....67

Configuring the Physical Layer Cell Identity
The cell ID, cell identity group and physical layer identity are interdependent parameters. In combination they are responsible for synchronization between network and user equipment.

The physical layer cell ID identifies a particular radio cell in the LTE network. The cell identities are divided into 168 unique cell identity groups. Each group consists of 3 physical layer identities. According to

$$N_{ID}^{cell} = 3 \cdot N_{ID}^{(1)} + N_{ID}^{(2)}$$

$N^{(1)}$ = cell identity group, {0...167}
$N^{(2)}$ = physical layer identity, {0...2}

there is a total of 504 different cell IDs.

If you change one of these three parameters, the R&S FSV automatically updates the other two.

For automatic detection of the cell ID, turn the "Auto" function on.

Before it can establish a connection, the user equipment must synchronize to the radio cell it is in. For this purpose, two synchronization signals are transmitted on the downlink. These two signals are reference signals whose content is defined by the "Physical Layer Identity" and the "Cell Identity Group".

The first signal is one of 3 possible Zadoff-Chu sequences. The sequence that is used is defined by the physical layer identity. It is contained in the P-SYNC.

The second signal is one of 168 unique sequences. The sequence is defined by the cell identity group. This sequence is contained in the S-SYNC.

In addition to the synchronization information, the cell ID also determines

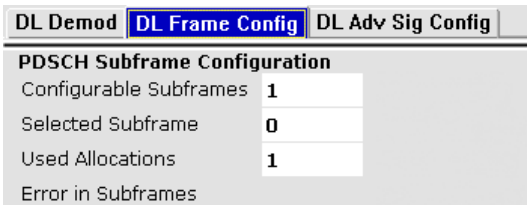
- the cyclic shifts for PCFICH, PHICH and PDCCH mapping,
- the frequency shifts of the reference signal.

Remote command:
Cell Identity Group:
`CONFigure[:LTE]:DL:PLC:CIDGroup` on page 135
`FETCh:PLC:CIDGroup?` on page 99
Identity
`CONFigure[:LTE]:DL:PLC:PLID` on page 135
`FETCh:PLC:PLID?` on page 99

5.7.3 Configuring PDSCH Subframes

The application allows you to configure individual subframes that are used to carry the information of the PDSCH. The PDSCH (Physical Downlink Shared Channel) primarily carries all general user data. It therefore takes up most of the space in a radio frame.

If you turn "Auto Demodulation" on, the appplication automatically determines the subframe configuration for the PDSCH. In the default state, automatic configuration is on.



Every LTE frame (FDD and TDD) contains 10 subframes. Each downlink subframe consists of one or more (resource) allocations. The R&S FSV shows the contents for each subframe in the configuration table. In the configuration table, each row corresponds to one allocation.

ID / N_RNTI	Code Word	Modulation	Number of RB	Offset RB	Rho A (Power)/dB	Confl.
0	1/1	QPSK	6	0	0 dB	

If there are any errors or conflicts between allocations in one or more subframes, the application shows the number of errors and the number of the corrupt subframe in the "Error in Subframes" field. It does not show the kind of error.

Before you start to work on the contents of each subframe, you should define the number of subframes you want to customize with the "Configurable Subframes" parameter. The application supports the configuration of up to 40 subframes.

Then you can select a particular subframe that you want to customize in the "Selected Subframe" field. Enter the number of the subframe (starting with 0). The application updates the contents of the configuration table to the selected subframe.

Configuring PDSCH Allocations.....69

Configuring PDSCH Allocations

In the default state, each subframe contains one allocation. Add allocations with the "Used Allocations" parameter. The application expands the configuration table accordingly with one row representing one allocation. You can define a different number of allocations for each subframe you want to configure and configure up to 110 allocations in every subframe.

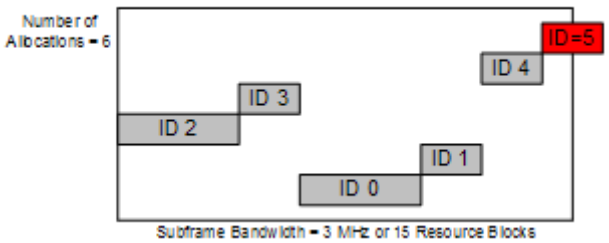
The configuration table contains the settings to configure the allocations.

- ID/N_RNTI
  Selects the allocation's ID. The ID corresponds to the N_RNTI.
  By default, the application assigns consecutive numbers starting with 0.
  The ID, or N_RNTI, is the user equipment identifier for the corresponding allocation and is a number in the range from 0 to 65535. The order of the numbers is irrelevant. You can combine allocations by assigning the same number more than once. Combining allocations assigns those allocations to the same user. Allocations with the same N_RNTI share the same modulation scheme and power settings.
- Code Word
  Shows the code word of the allocation.
  The code word is made up out of two numbers. The first number is the number of the code word in the allocation. The second number is the total number of code words that the allocation includes. Thus, a table entry of "1/2" would mean that the row corresponds to code word 1 out of 2 code words in the allocation.
- Modulation
  Selects the modulation scheme for the corresponding allocation.
  The modulation scheme for the PDSCH is either QPSK, 16QAM or 64QAM.
- VRB Gap
  Turns the utilization of virtual resource blocks (VRB) on and off.
  The standard defines two types of VRBs. Localized VRBs and distributed VRBs. While localized VRBs have a direct mapping to the PRBs, distributed VRBs result in a better frequency diversity.
  Three values of VRB gap are allowed.
  – **0** = Localized VRBs are used.
  – **1** = Distributed VRBs are used and the first gap is applied.
  – **2** = Distributed VRBs are used and the second gap is applied (for channel bandwidths > 50 resource blocks).
    The second gap has a smaller size compared to the first gap.

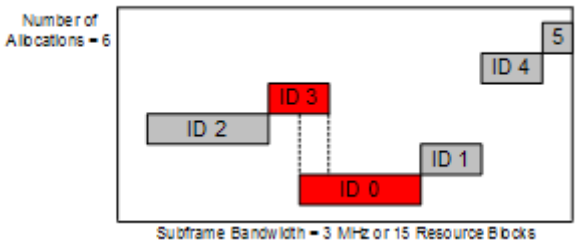
  If on, the VRB Gap determines the distribution and mapping of the VRB pairs to the physical resource blocks (PRB) pairs.

The distribution of the VRBs is performed in a way that consecutive VRBs are spread over the frequencies and are not mapped to PRBs whose frequencies are next to each other. Each VRB pair is split into two parts which results in a frequency gap between the two VRB parts. This method corresponds to frequency hopping on a slot basis.
The information whether localized or distributed VRBs are applied is carried in the PDCCH. The DCI formats 1A, 1B and 1D provide a special 1-bit flag for this purpose ("Localized / Distributed VRB Assignment"). Another bit in the DCI formats controls whether the first or second bit is applied.

- Number of RB
  Defines the number of resource blocks the allocation covers. The number of resource blocks defines the size or bandwidth of the allocation.
  If you allocate too many resource blocks compared to the bandwidth you have set, the R&S FSV will show an error message in the "Conflicts" column and the "Error in Subframes" field.
- Offset RB
  Sets the resource block at which the allocation begins.
  A wrong offset for any allocation would lead to an overlap of allocations. In that case the application will show an error message.
- Power [dB]
  Sets the boosting of the allocation. Boosting is the allocation's power relative to the reference signal power.
- Conflict
  In case of a conflict, the application shows the type of conflict and the ID of the allocations that are affected. Possible conflicts are:
  – bandwidth error (">BW")
    A bandwidth error occurs when the number of resource blocks in the subframe exceeds the bandwidth you have set.



  – RB overlap errors
    An RB overlap error occurs if one or more allocations overlap. In that case, check if the length and offset values of the allocations are correct.



Remote command:
Configurable Subframes:
`CONFigure[:LTE]:DL:CSUBframes` on page 136
Used Allocations:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALCount` on page 136
Modulation:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]:MODulation` on page 137
Number of RB:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount` on page 137
Offset RB:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOFfset` on page 138
Power:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWer` on page 137

5.8 Defining Advanced Signal Characteristics

The downlink advanced signal characteristics contain settings that describe the detailed structure of a downlink LTE signal.

You can find the advanced signal characteristics in the "Demod Settings" dialog box.

5.8.1 Defining the PDSCH Resource Block Symbol Offset

The PDSCH Resource Block (PRB) symbol offset is part of the global settings in the "Downlink Adv Sig Config" tab of the "Demodulation Settings" dialog box.

PRB Symbol Offset.....72

PRB Symbol Offset
PRB Symbol Offset specifies the symbol offset of the PDSCH allocations relative to the subframe start. This setting applies to all subframes in a frame.

With this settings, the number of OFDM symbols used for control channels is defined, too. For example, if this parameter is set to 2 and the PDCCH is enabled, the number of OFDM symbols actually used by the PDCCH is 2.

Special control channels like the PCFICH or PHICH require a minimum number of control channel OFDM symbols at the beginning of each subframe. If PRB Symbol Offset is lower than the required value, the control channel data overwrites some resource elements of the PDSCH.

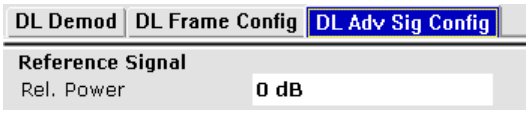
If Auto is selected, the Control Region for PDCCH (PRB Symbol Offset) value is detected from the PCFICH. For correct Demodulation of a 3GPP conform PCFICH signal, the Scrambling of Coded Bits has to be enabled.

Remote command:
`CONFigure[:LTE]:DL:PSOFfset` on page 138

5.8.2 Configuring the Reference Signal

The reference signal settings contain settings to describe the physical attributes and structure of the reference signal.

The reference signal settings are part of the "Downlink Adv Sig Config" tab of the "Demodulation Settings" dialog box.



Rel Power (Reference Signal).....72

Rel Power (Reference Signal)
Defines the relative power of the reference signal compared to all the other physical signals and physical channels.

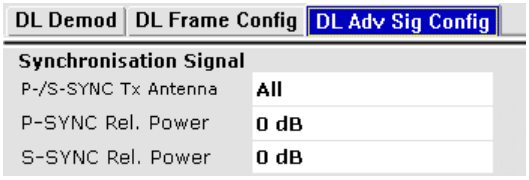
Note that this setting gives you an offset to all other relative power settings.

Remote command:
`CONFigure[:LTE]:DL:REFSig:POWer` on page 139

5.8.3 Configuring the Synchronization Signal

The synchronization signal settings contain settings to describe the physical attributes and structure of the synchronization signal.

The synchronization signal settings are part of the "Downlink Adv Sig Config" tab of the "Demodulation Settings" dialog box.



P-/S-SYNC Tx Antenna....73
P-SYNC Relative Power....73
S-SYNC Relative Power....73

P-/S-SYNC Tx Antenna
Selects the antenna that transmits the P-SYNC and the S-SYNC.

When selecting the antenna, you implicitly select the synchronization method. If the selected antenna transmits no synchronization signal, the application uses the reference signal to synchronize. Note that automatic cell ID detection is not available if synchronization is based on the reference signal.

Remote command:
`CONFigure[:LTE]:DL:SYNC:ANTenna` on page 139

P-SYNC Relative Power
Defines the power of the P-SYNC signals relative to the reference signal.

Remote command:
`CONFigure[:LTE]:DL:SYNC:PPOWer` on page 139

S-SYNC Relative Power
Defines the power of the S-SYNC signals relative to the reference signal.

Remote command:
`CONFigure[:LTE]:DL:SYNC:SPOWer` on page 140

5.8.4 Configuring the Control Channels

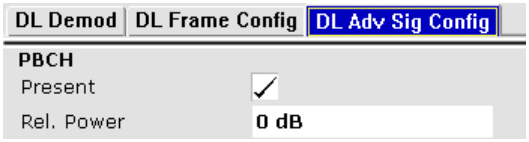
The control channel settings contain setting that describe the physical attributes and structure of the control channel.

The control channel settings are part of the "Downlink Signal Characteristics" tab of the "Demodulation Settings" dialog box.

- Configuring the PBCH....73
- Configuring the PCFICH....74
- Configuring the PHICH....74
- Configuring the PDCCH....76

5.8.4.1 Configuring the PBCH

The physical broadcast channel (PBCH) carries system information for the user equipment. You can include or exclude the PBCH in the test setup and define the relative power of this channel.



PBCH Present
Includes or excludes the PBCH from the test setup.

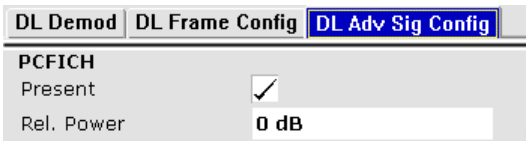
Remote command:
`CONFigure[:LTE]:DL:PBCH:STAT` on page 140

PBCH Relative Power
Defines the power of the PBCH relative to the reference signal.

Remote command:
`CONFigure[:LTE]:DL:PBCH:POWer` on page 140

5.8.4.2 Configuring the PCFICH

The physical control format indicator channel (PCFICH) carries information about the format of the PDCCH. You can include or exclude the PCFICH in the test setup and define the relative power of this channel.



PCFICH Present
Includes or excludes the PCFICH from the test setup.

Remote command:
`CONFigure[:LTE]:DL:PCFich:STAT` on page 141

PCFICH Relative Power
Defines the power of the PCFICH relative to the reference signal.

Remote command:
`CONFigure[:LTE]:DL:PCFich:POWer` on page 141

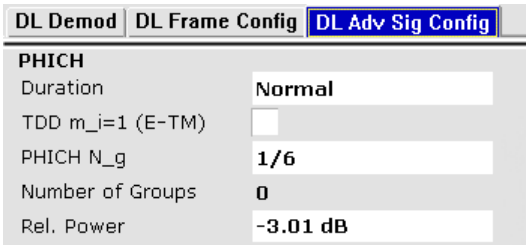
5.8.4.3 Configuring the PHICH

The physical hybrid ARQ indicator channel (PHICH) contains the hybrid ARQ indicator. The hybrid ARQ indicator contains the acknowledgement / negative acknowledgments for uplink blocks.

You can set several specific parameters for the PHICH.

Turning off the PHICH

If you set the value of the PHICH N_g to Custom and at the same time define "0" PHICH groups, the PHICH is excluded from the signal.



PHICH Duration

Selects the duration of the PHICH. Normal and extended duration are supported.

With a normal duration, all resource element groups of the PHICH are allocated on the first OFDM symbol.

With an extended duration, the resource element groups of the PHICH are distributed over three OFDM symbols for a normal subframe or over two symbols within a special subframe.

If you select Auto, the duration of PHICH is automatically determined and based on the PBCH decoding results.

Note that you have to turn on the PBCH for an automatic detetemination of the PHICH duration.

Remote command:

`CONFigure[:LTE]:DL:PHICh:DURation` on page 142

PHICH TDD m_i=1 (E-TM)

Turns the special setting of the PHICH for the enhanced test models on and off.

The special setting is defined in 36.141 V9.0.0, 6.1.2.6: "For frame structure type 2 the factor m_i shall not be set as per TS36.211, Table 6.9-1, but instead shall be set to m_i=1 for all transmitted subframes."

The parameter is available if you have selected TDD.

Remote command:

`CONFigure[:LTE]:DL:PHICh:MITM` on page 142

PHICH N_g

Sets the variable N_g.

N_g in combination with the number of resource blocks defines the number of PHICH groups in a downlink subframe. The standard specifies several values for N_g that you can select from the dropdown menu.

If you need a customized configuration, you can set the number of PHICH groups in a subframe by selecting the "Custom" menu item and set a number of PHICH groups directly with PHICH Number of Groups.

Remote command:
`CONFigure[:LTE]:DL:PHICh:NGParameter` on page 143

PHICH Number of Groups
Sets the number of PHICH groups contained in a subframe.

To select a number of groups, you have to set the PHICH N_g to "Custom".

Remote command:
`CONFigure[:LTE]:DL:PHICh:NOGRoups` on page 143

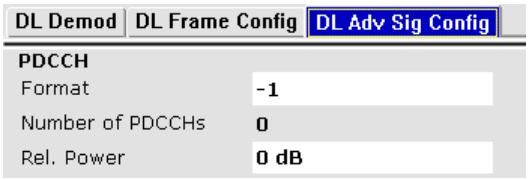
PHICH Rel Power
Defines the power of the PHICH relative to the reference signal.

Remote command:
`CONFigure[:LTE]:DL:PHICh:POWer` on page 143

5.8.4.4 Configuring the PDCCH

The physical downlink control channel (PDCCH) carries the downlink control information.

The PDCCH is always present. You can define several specific parameters for the PDCCH.



PDCCH Format
Defines the format of the PDCCH (physical downlink control channel).

Note that PDCCH format "-1" is not defined in the standard. This format corresponds to the transmission of one PDCCH on all available resource element groups. As a special case for this PDCCH format, the center of the constellation diagram is treated as a valid constellation point.

Remote command:
`CONFigure[:LTE]:DL:PDCCh:FORMat` on page 141

Number of PDCCHs
Sets the number of physical downlink control channels.

This parameter is available if the PDCCH format is -1.

Remote command:
`CONFigure[:LTE]:DL:PDCCh:NOPD` on page 141

PDCCH Rel Power
Defines the power of the PDCCH relative to the reference signal.

Remote command:
`CONFigure[:LTE]:DL:PDCCh:POWer` on page 142

6 Analyzing Measurement Results

The "Measurement Settings" contain settings that configure various result displays. These settings are independent of the signal, they adjust the display of the results. You can open the dialog box with the "Meas Settings" softkey. The corresponding dialog box is made up of three tabs. By default, the "Selection" tab is the active one.

- Selecting a Particular Signal Aspect.....78
- Defining Measurement Units.....79
- Defining Various Measurement Parameters.....79
- Selecting the Contents of a Constellation Diagram.....80
- Scaling the Y-Axis.....81
- Using Markers.....82

6.1 Selecting a Particular Signal Aspect

In the "Selection" tab of the "Measurement Settings" dialog box you can select specific parts of the signal you want to analyze.

Subframe Selection
Selects a particular subframe whose results the software displays.

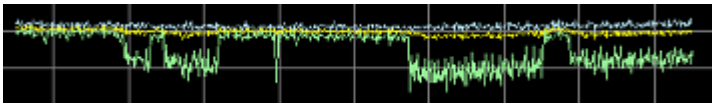
You can select a particular subframe for the following measurements.

Result Summary, EVM vs. Carrier, EVM vs. Symbol, Channel Flatness, Channel Group Delay, Channel Flatness Difference, Constellation Diagram, Allocation Summary and Bit Stream. If ---All--- is selected, either the results from all subframes are displayed at once or a statistic is calculated over all analyzed subframes.

Selecting "All" either displays the results over all subframes or calculates a statistic over all subframes that have been analyzed.

Example: Subframe selection

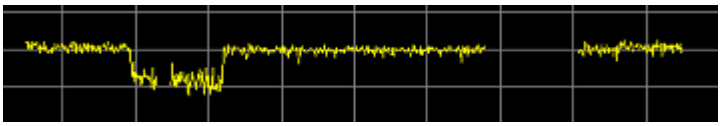
If you select all subframes ("All"), the application shows three traces. One trace shows the subframe with the minimum level characteristics, the second trace shows the subframe with the maximum level characteristics and the third subframe shows the averaged level characteristics of all subframes.



with AV MI PK

- PK: peak value
- AV: average value
- MI: minimum value

If you select a specific subframe, the application shows one trace. This trace contains the results for that subframe only.



Remote command:
`[SENSe][:LTE]:SUBFrame:SELect` on page 144

6.2 Defining Measurement Units

In the "Units" tab of the "Measurement Settings" dialog box you can select the unit for various measurement results.

EVM Unit
Selects the unit for graphic and numerical EVM measurement results.

Possible units are dB and %.

Remote command:
`UNIT:EVM` on page 145

6.3 Defining Various Measurement Parameters

In the "Misc" tab of the "Measurement Settings" dialog box you can set various parameters that affect some result displays.

Bit Stream Format
Selects the way the bit stream is displayed.

The bit stream is either a stream of raw bits or of symbols. In case of the symbol format, the bits that belong to a symbol are shown as hexadecimal numbers with two digits.

Examples:

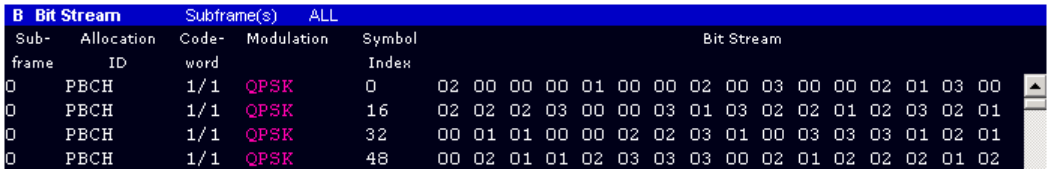


Fig. 6-1: Bit stream display in downlink application if the bit stream format is set to "symbols"

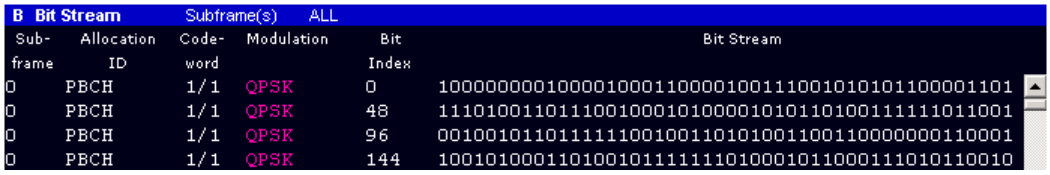


Fig. 6-2: Bit stream display in downlink application if the bit stream format is set to "bits"

Remote command:
UNIT:BSTR on page 144

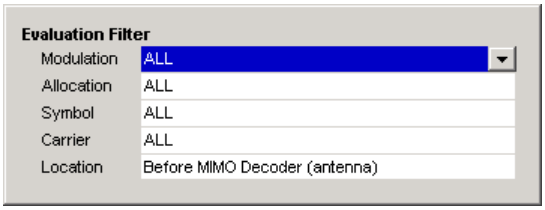
6.4 Selecting the Contents of a Constellation Diagram

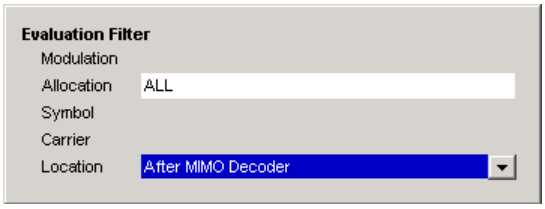
The "Evaluation Filter" dialog box contains settings to configure the contents of a constellation diagram.

You can access the dialog box with the "Constellation Selection" softkey in the "Measurement" menu.

Evaluation Range for the Constellation Diagram
The "Evaluation Range" dialog box defines the type of constellation points that are displayed in the Constellation Diagram.

By default the R&S FSV displays all constellation points of the data that have been evaluated. However, you can filter the results by several aspects.





- Modulation
  Filters the results to include only the selected type of modulation.
- Allocation

Filters the results to include only a particular type of allocation.

- Symbol
  Filters the results to include only a particular OFDM symbol.
- Carrier
  Filters the results to include only a particular subcarrier.
- Location
  Note that the PHICH is CDMA encoded. Thus, the constellation points for the PHICH are either created before or after CDMA encoding.
  If you have selected "After MIMO/CDMA Decoder", filtering by "Symbol" and "Carrier" is not available.

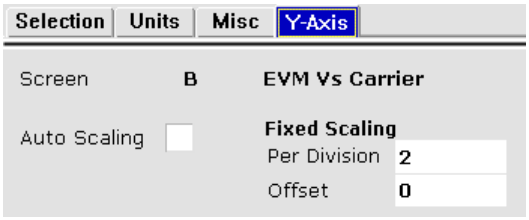
The result display is updated as soon as you make the changes.

Note that the constellation selection is applied to all windows in split screen mode if the windows contain constellation diagrams.

Remote command:
Location:
`CONFigure[:LTE]:DL:CONS:LOCation` on page 144

6.5 Scaling the Y-Axis

In the "Y-Axis" tab of the "Measurement Settings" dialog box you can set various parameters that affect some result displays.



Y-Axis Scale
The y-axis scaling determines the vertical resolution of the measurement results. The scaling you select always applies to the currently active screen and the corresponding result display.

Usually, the best way to view the results is if they fit ideally in the diagram area in order to view the complete trace. This is the way the application scales the y-axis if you have turned on **automatic scaling**.

But it may become necessary to see a more detailed version of the results. In that case, turn on fixed scaling for the y-axis. **Fixed scaling** becomes available when you turn off automatic scaling. For a fixed scaling, define the distance between two grid lines (scaling **per division**) and the point of origin of the y-axis (the **offset**).

Remote command:
Automatic scaling:
`DISPlay[:WINDow]:TRACe:Y:SCALe:AUTO` on page 150
Manual scaling:
`DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:OFFSet` on page 150
`DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:PERDiv` on page 151

6.6 Using Markers

The firmware application provides marker functionality to work with. You can use a marker to mark specific points on traces or to read out measurement results.

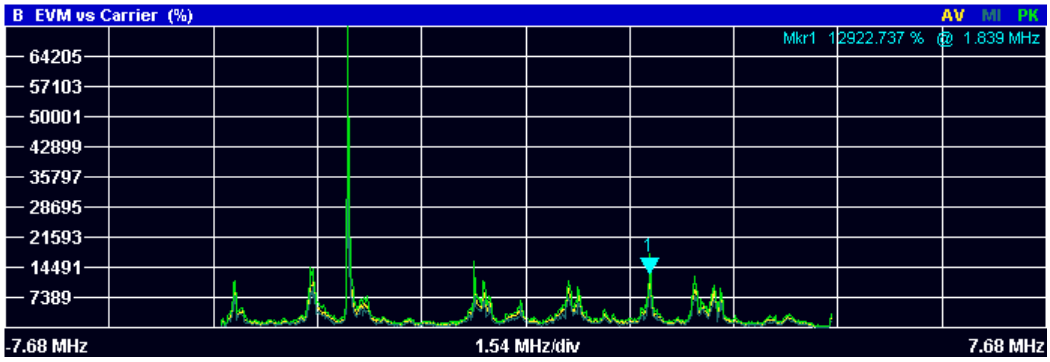


Fig. 6-3: Example: Marker

The MKR key opens the corresponding submenu. You can activate up to four markers with the "Marker <x>" softkeys. The first marker is always a normal marker. Markers 2 to 4 are delta marker by default. The reference marker for the delta marker is marker 1. You can turn all delta markers into normal markers with the "Marker (Norm Delta)" softkey.

After pressing the "Marker <x>" softkey, you can set the position of the marker in several ways.

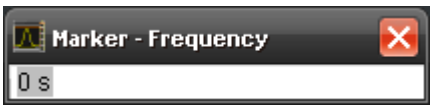
- Enter a frequency value in the marker input field.
- Move the marker with the rotary knob.
- Position the marker to the trace minimum or trace maximum with the "Marker Max" or "Marker Min" softkeys.

The current marker frequency and the corresponding level is displayed in the upper right corner of the trace display.

The "Marker <x>" softkey have three possible states:

- If the "Marker <x>" softkey is black, the marker is off.

- After pressing the "Marker <x>" softkey it turns orange to indicate an open dialog box and the the marker is active. The dialog box to specify the marker position on the frequency axis opens.



- After closing the dialog box, the "Marker <x>" softkey turns blue. The marker stays active.

Pressing the "Marker <x>" softkey again deactivates the marker. You can also turn off the marker by pressing the "All Marker Off" softkey.

If you'd like to see the area of the spectrum around the marker in more detail, you can use the Marker Zoom function. Press the "Marker Zoom" softkey to open a dialog box in which you can specify the zoom factor. The maximum possible zoom factor depends on the result display. The "Unzoom" softkey cancels the marker zoom.

Note that the zoom function is not available for all result displays.

If you have more than one active trace, it is possible to assign the marker to a specific trace. Press the "Marker ➞ Trace" softkey in the marker to menu and specify the trace in the corresponding dialog box.

SCPI commands:

See chapter 8.8.2, "Marker and Delta Marker", on page 145.

7 File Management

7.1 File Manager

The root menu of the application includes a File Manager with limited functions for quick access to file management functionality.

Loading a Frame Setup

The frame setup or frame description describes the complete modulation structure of the signal, such as bandwidth, modulation, etc.

The frame setup is stored as an XML file. XML files are very commonly used to describe hierarchical structures in an easy-to-read format for both humans and PC.

A typical frame setup file would look like this:

```
<FrameDefinition LinkDirection="downlink" TDDULDLAllocationConfiguration="0"
RessourceBlocks="50" CP="auto" RefSigSubcarrierOffset="Auto" PSYNCBoostingdB="0"
SSYNCBoostingdB="0" ReferenceSignalBoostingdB="0" PBCHSymbolOffset="7" PBCHLength="4"
PCFICHIsPresent="false" PHICHNumGroups="0" PHICHDuration="Normal" PHICHBoostingdB="0"
PDCCHIsPresent="false" PSSYNCRepetitionPeriod="10" DataSymbolOffsetSubFrame="2"
MIMOConfiguration="1 Tx Antenna" MIMOAntennaSelection="Antenna 1" PhysLayCellIDGrp="Auto"
PhysLayID="Auto" RefSignal3GPPVersion="2" N_c_fastforward="0">
 <Frame>
  <Subframe>
   <PRBs>
    <PRB Start="0" Length="6" Boosting="0" Modulation="QPSK"/>
   </PRBs>
  </Subframe>
 </Frame>
 <stControl PhaseTracking="1" TimingTracking="0" ChannelEstimation="1"
  EVMCCalculationMethod="1" EnableScrambling="1" AutoDemodulation="1"/>
</FrameDefinition>
```

All settings that are available in the "Demod Settings" dialog box are also in the frame setup file. You can enter additional allocations by adding additional PRB entries in the PRBs list.

Note that at least one PRB must exist.

To load a frame setup, press the "File Manager" softkey in the root menu of the application. Select the file you want to load and activate it with the "Load Demod Setup" button.

Loading an I/Q File

The R&S FSV is able to process I/Q data that has been captured with a R&S FSV directly as well as data stored in a file. You can store I/Q data in various file formats in order to be able to process it with other external tools or for support purposes.

I/Q data can be formatted either in binary form or as ASCII files. The data is linearly scaled using the unit Volt (e.g. if a correct display of Capture Buffer power is required). For **binary** format, data is expected as 32-bit floating point data, Little Endian format (also known as LSB Order or Intel format). An example for binary data would be: 0x1D86E7BB in hexadecimal notation is decoded to -7.0655481E-3. The order of the data is either IQIQIQ or II...IQQ...Q.

For ASCII format, data is expected as I and Q values in alternating rows, separated by new lines: <I value 1>, <Q value 1>, <I value 2>, <Q value 2>, ...

To use data that has been stored externally, press the "File Manager" softkey in the root menu of the application. Select the file you want to load and activate it with the "Load IQ Data" button.

7.2 SAVE/RECALL Key

Besides the file manager in the root menu, you can also manage the data via the SAVE/RECALL key.

The corresponding menu offers full functionality for saving, restoring and managing the files on the R&S FSV. The save/recall menu is the same as that of the spectrum mode. For details on the softkeys and handling of this file manager, refer to the operating manual of the R&S FSV.

8 Remote Commands

- Overview of Remote Command Suffixes....86
- Introduction....86
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- Remote Commands to Perform Measurements....96
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- Analyzing Measurement Results....144
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8.1 Overview of Remote Command Suffixes

This chapter provides an overview of all suffixes used for remote commands in the LTE application.

Suffix	Description
<allocation>	Selects an allocation.
<analyzer>	No effect.
<antenna>	Selects an antenna for MIMO measurements.
<cluster>	Selects a cluster (uplink only).
<cwnum>	Selects a codeword.
<k>	Selects a limit line. Irrelevant for the LTE application.
<m>	Selects a marker. Irrelevant for the LTE application.
<n>	Selects a measurement window.
<subframe>	Selects a subframe.
<t>	Selects a trace. Irrelevant for the LTE application.

8.2 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a SCPI command consists of a header and, in most cases, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the User Manual of the R&S FSV.

Remote command examples

Note that some remote command examples mentioned in this general introduction may not be supported by this particular application.

8.2.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitely.
- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.
  Parameters that are only returned as the result of a query are indicated as **Return values**.
- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S FSV follow the SCPI syntax rules.
- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.
- **Reset values (*RST)**
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as ***RST** values, if available.
- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

8.2.2 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

8.2.3 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't quote a suffix for keywords that support one, a 1 is assumed.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

8.2.4 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

`[SENSe:]FREQuency:CENTer` is the same as `FREQuency:CENTer`

With a numeric suffix in the optional keyword:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe`

`DISPlay:ZOOM:STATe ON` enables the zoom in window 1 (no suffix).

`DISPlay:WINDow4:ZOOM:STATe ON` enables the zoom in window 4.

8.2.5 Alternative Keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

8.2.6 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

`LAYout:ADD:WINDow Spectrum,LEFT,MTABle`

Parameters may have different forms of values.

- Numeric Values....89
- Boolean....90
- Character Data....90
- Character Strings....91
- Block Data....91

8.2.6.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- MIN/MAX
  Defines the minimum or maximum numeric value that is supported.
- DEF
  Defines the default value.

- UP/DOWN
  Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- INF/NINF
  Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- NAN
  Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

8.2.6.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

8.2.6.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see chapter 8.2.2, "Long and Short Form", on page 88.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

8.2.6.4 Character Strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

```
INSTRument:DELete 'Spectrum'
```

8.2.6.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

8.3 Selecting and Configuring Measurements

8.3.1 Selecting Measurements

CALCulate<n>:FEED....91
DISPlay[:WINDow<n>]:TABLe....93

CALCulate<n>:FEED <DispType>

This command selects the measurement and result display.

Parameters:

<DispType> String containing the short form of the result display.

'EVM:EVCA' (EVM vs carrier result display)
'EVM:EVRP' (EVM vs RB)
'EVM:EVSY' (EVM vs symbol result display)
'EVM:FEVS' (frequency error vs symbol result display)
'EVM:EVSU' (EVM vs subframe result display)
'PVT:CBUF' (capture buffer result display)
'PVT:OOP' (on/off power result display)
'SPEC:SEM' (spectrum emission mask)
'SPEC:ACP' (ACLR)
'SPEC:PSPE' (power spectrum result display)
'SPEC:PVRP' (power vs RB PDSCH result display
'SPEC:PVRR' (power vs RB RS result display)
'SPEC:FLAT' (spectrum flatness result display)
'SPEC:GDEL' (group delay result display)
'SPEC:FDIF' (flatness difference result display)
'CONS:CONS' (constellation diagram)
'STAT:BSTR' (bitstream)
'STAT:ASUM' (allocation summary)
'STAT:CCDF' (CCDF)

Example:

```
CALC2:FEED 'PVT:CBUF'
```

Select Capture Buffer to be displayed on screen B.

Manual operation:

See "Capture Buffer" on page 31
See "On / Off Power" on page 32
See "EVM vs Carrier" on page 35
See "EVM vs Symbol" on page 36
See "Frequency Error vs Symbol" on page 36
See "EVM vs Subframe" on page 37
See "Spectrum Mask" on page 38
See "ACLR" on page 40
See "Power Spectrum" on page 41
See "Power vs Resource Block PDSCH" on page 42
See "Power vs Resource Block RS" on page 42
See "Channel Flatness" on page 43
See "Channel Group Delay" on page 43
See "Channel Flatness Difference" on page 44
See "Constellation Diagram" on page 45
See "CCDF" on page 45
See "Allocation Summary" on page 46
See "Bit Stream" on page 47

DISPlay[:WINDow<n>]:TABLe <State>

This command turns the result summary on and off.

Parameters:

<State>

ON
Turns the result summary on and removes all graphical results from the screen.

OFF
Turns the result summary off and restores the graphical results that were previously set.

Example: `DISP:TABL OFF`
Turns the result summary off.

Manual operation: See "Result Summary" on page 28

8.3.2 Configuring Frequency Sweep Measurements

ACLR and SEM measurements feature some settings particular to those measurements.

[SENSe]:POWer:ACHannel:AACHannel....93
[SENSe]:POWer:ACHannel:BANDwidth:CHANnel2....94
[SENSe]:POWer:ACHannel:SPACing:CHANnel....94
[SENSe]:POWer:ACHannel:TXCHannels:COUNt....94
[SENSe]:POWer:NCORrection....95
[SENSe]:POWer:SEM:CATegory....95
[SENSe]:SWEep:EGATe:AUTO....95

[SENSe]:POWer:ACHannel:AACHannel <Channel>

This command selects the assumed adjacent channel carrier for ACLR measurements.

Parameters:

<Channel>

EUTRA
Selects an EUTRA signal of the same bandwidth like the TX channel as assumed adjacent channel carrier.

UTRA128
Selects an UTRA signal with a bandwidth of 1.28MHz as assumed adjacent channel carrier.

UTRA384
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

UTRA768
Selects an UTRA signal with a bandwidth of 7.68MHz as assumed adjacent channel carrier.

*RST: EUTRA

Example: POW:ACH:AACH UTRA384
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

Manual operation: See "Assumed Adjacent Channel Carrier" on page 58

[SENSe]:POWer:ACHannel:BANDwidth:CHANnel2 <Bandwidth>

This command defines the channel bandwidth of the second TX channel in ACLR measurements.

Before you can use the command, you have to select two TX channels for the ACLR measurement with [SENSe]:POWer:ACHannel:TXCHannels:COUNt on page 94.

Note that you have to add a suffix with the value "2" at the CHANnel syntax element.

Parameters:

<Bandwidth> Bandwidth of the second TX channel in Hz.
Supported LTE bandwidths are listed in the description of CONFigure[:LTE]:DL:BW on page 119.

Example: POW:ACH:TXCH:COUN 2
POW:ACH:BAND:CHAN2 BW15_00
Defines a bandwidth of 15 MHz for the second TX channel.

Manual operation: See "Number of TX Channels" on page 59

[SENSe]:POWer:ACHannel:SPACing:CHANnel <Distance>

This command defines the distance between the first and the second TX channel for ACLR measurements.

Before you can use the command, you have to select two TX channels for the ACLR measurement with [SENSe]:POWer:ACHannel:TXCHannels:COUNt on page 94.

Parameters:

<Distance> Distance from the center of the first TX channel to the center of the second TX channel in Hz.

Example: POW:ACH:TXCH:COUN 2
POW:ACH:SPAC:CHAN 10MHZ
Defines a channel spacing of 10 MHz.

Manual operation: See "Number of TX Channels" on page 59

[SENSe]:POWer:ACHannel:TXCHannels:COUNt <TXChannels>

This command selects the number of transmission (TX) channels in ACLR measurements.

Parameters:

<TXChannels> Number of transmission channels.

1
One TX channel is analyzed in ACLR measurements.

2
Two TX channels are analyzed in ACLR measurements.

Example: `POW:ACH:TXCH:COUN 2`
Selects two TX channels for the ACLR measurement.

Manual operation: See "Number of TX Channels" on page 59

[SENSe]:POWer:NCORrection <State>

This command turns noise correction for ACLR measurements on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `POW:NCOR ON`
Activates noise correction.

Manual operation: See "Noise Correction" on page 59

[SENSe]:POWer:SEM:CATegory <Category>

This command selects the SEM limit category as defined in 3GPP TS 36.104.

Parameters:

<Category> **A**
Category A

B
Category B

*RST: A

Example: `POW:SEM:CAT B`
Selects SEM category B.

Manual operation: See "Category" on page 58

[SENSe]:SWEep:EGATe:AUTO <State>

This command turns auto gating for SEM and ACLR measurements on and off.

This command is available for TDD measurements in combination with an external or IF power trigger.

Parameters:

<State>

ON
Evaluates the on-period of the LTE signal only.

OFF
Evaluates the complete signal.

Example: `SWE:EGAT:AUTO ON`
Turns auto gating on.

Manual operation: See "Auto Gating" on page 57

8.4 Remote Commands to Perform Measurements

INITiate:CONTinuous....96
INITiate[:IMMediate]....96
INITiate:REFResh....97
[SENSe][:LTE]:OOPower:ATIMing....97
[SENSe]:SYNC[:STATe]?....97

INITiate:CONTinuous <State>

This command controls the sweep mode.

Parameters:

<State> ON | OFF

ON
Continuous sweep

OFF
Single sweep

*RST: OFF

Example: `INIT:CONT OFF`
Switches the sequence to single sweep.
`INIT:CONT ON`
Switches the sequence to continuous sweep.

Manual operation: See "Single Sweep and Continuous Sweep" on page 48

INITiate[:IMMediate]

This command initiates a new measurement sequence.

With a frame count > 0, this means a restart of the corresponding number of measurements.

In single sweep mode, you can synchronize to the end of the measurement with `*OPC`. In continuous sweep mode, synchronization to the end of the sweep is not possible.

Example: `INIT`
Initiates a new measurement.

Usage: Event

INITiate:REFResh

This command updates the current I/Q measurement results to reflect the current measurement settings.

No new I/Q data is captured. Thus, measurement settings apply to the I/Q data currently in the capture buffer.

The command applies exclusively to I/Q measurements. It requires I/Q data.

Example: `INIT:REFR`
The application updates the IQ results

Usage: Event

Manual operation: See "Refresh" on page 49

[SENSe][:LTE]:OOPower:ATIMing

This command adjusts the timing for On/Off Power measurements.

Example: `OOP:ATIM`
Adjusts the On/Off Power timing.

Usage: Event

Manual operation: See "On / Off Power" on page 32
See "Adjust Timing" on page 49

[SENSe]:SYNC[:STATe]?

This command queries the current synchronization state.

Return values:

<State> The string contains the following information.
- <OFDMSymbolTiming> is the coarse symbol timing
- <P-SYNCSynchronization> is the P-SYNC synchronization state
- <S-SYNCSynchronization> is the S-SYNC synchronization state

A zero represents a failure and a one represents a successful synchronization.

Example: `SYNC:STAT?`
Would return, e.g. '1,1,0' if coarse timing and P-SYNC were successful but S-SYNC failed.

Usage: Query only

8.5 Remote Commands to Read Numeric Results

FETCh:CYCPrefix?....99
FETCh:PLC:CIDGroup?....99
FETCh:PLC:PLID?....99
FETCh:SUMMary:CRESt[:AVERage]?....99
FETCh:SUMMary:EVM[:ALL]:MAXimum?....100
FETCh:SUMMary:EVM[:ALL]:MINimum?....100
FETCh:SUMMary:EVM[:ALL][:AVERage]?....100
FETCh:SUMMary:EVM:DSQP:MAXimum?....100
FETCh:SUMMary:EVM:DSQP:MINimum?....100
FETCh:SUMMary:EVM:DSQP[:AVERage]?....100
FETCh:SUMMary:EVM:DSST:MAXimum?....100
FETCh:SUMMary:EVM:DSST:MINimum?....100
FETCh:SUMMary:EVM:DSST[:AVERage]?....100
FETCh:SUMMary:EVM:DSSF:MAXimum?....101
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FETCh:CYCPrefix?

This command queries the cyclic prefix type that has been detected.

Return values:

<PrefixType> The command returns -1 if no valid result has been detected yet.

NORM
Normal cyclic prefix length detected

EXT
Extended cyclic prefix length detected

Example: `FETC:CYCP?`
Returns the current cyclic prefix length type.

Usage: Query only

FETCh:PLC:CIDGroup?

This command queries the cell identity group that has been detected.

Return values:

<CidGroup> The command returns -1 if no valid result has been detected yet.

Range: 0 to 167

Example: `FETC:PLC:CIDG?`
Returns the current cell identity group.

Usage: Query only

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 67

FETCh:PLC:PLID?

This command queries the cell identity that has been detected.

Return values:

<Identity> The command returns -1 if no valid result has been detected yet.

Range: 0 to 2

Example: `FETC:PLC:PLID?`
Returns the current cell identity.

Usage: Query only

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 67

FETCh:SUMMary:CRESt[:AVERage]?

This command queries the average crest factor as shown in the result summary.

Return values:

<CrestFactor> <numeric value>
Crest Factor in dB.

Example: `FETC:SUMM:CRES?`
Returns the current crest factor in dB.

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:EVM[:ALL]:MAXimum?
FETCh:SUMMary:EVM[:ALL]:MINimum?
FETCh:SUMMary:EVM[:ALL][:AVERage]?

This command queries the EVM of all resource elements.

Return values:

<EVM> <numeric value>
Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM?`
Returns the mean value.

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:EVM:DSQP:MAXimum?
FETCh:SUMMary:EVM:DSQP:MINimum?
FETCh:SUMMary:EVM:DSQP[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a QPSK modulation.

Return values:

<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSQP?`
Returns the PDSCH QSPK EVM.

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:EVM:DSST:MAXimum?
FETCh:SUMMary:EVM:DSST:MINimum?
FETCh:SUMMary:EVM:DSST[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a 16QAM modulation.

Return values:

<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSST?`

Returns the PDSCH 16QAM EVM.

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:EVM:DSSF:MAXimum?
FETCh:SUMMary:EVM:DSSF:MINimum?
FETCh:SUMMary:EVM:DSSF[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a 64QAM modulation.

Return values:

<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSSF?`

Returns the PDSCH 64QAM EVM.

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:EVM:PCHannel:MAXimum?
FETCh:SUMMary:EVM:PCHannel:MINimum?
FETCh:SUMMary:EVM:PCHannel[:AVERage]?

This command queries the EVM of all physical channel resource elements.

Return values:

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:PCH?`

Returns the mean value.

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:EVM:PSIGnal:MAXimum?
FETCh:SUMMary:EVM:PSIGnal:MINimum?
FETCh:SUMMary:EVM:PSIGnal[:AVERage]?

This command queries the EVM of all physical signal resource elements.

Return values:

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:PSIG?`
Returns the mean value.

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:FERRor:MAXimum?
FETCh:SUMMary:FERRor:MINimum?
FETCh:SUMMary:FERRor[:AVERage]?

This command queries the frequency error.

Return values:

<FreqError> <numeric value>

Minimum, maximum or average frequency error, depending on the last command syntax element.

Default unit: Hz

Example: `FETC:SUMM:FERR?`
Returns the average frequency error in Hz.

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:GIMBalance:MAXimum?
FETCh:SUMMary:GIMBalance:MINimum?
FETCh:SUMMary:GIMBalance[:AVERage]?

This command queries the I/Q gain imbalance.

Return values:

<GainImbalance> <numeric value>

Minimum, maximum or average I/Q imbalance, depending on the last command syntax element.

Default unit: dB

Example: `FETC:SUMM:GIMB?`
Returns the current gain imbalance in dB.

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:IQOFfset:MAXimum?
FETCh:SUMMary:IQOFfset:MINimum?
FETCh:SUMMary:IQOFfset[:AVERage]?

This command queries the I/Q offset.

Return values:

<IQOffset> <numeric value>

Minimum, maximum or average I/Q offset, depending on the last command syntax element.

Default unit: dB

Example: `FETC:SUMM:IQOF?`

Returns the current IQ-offset in dB

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:OSTP:MAXimum?
FETCh:SUMMary:OSTP:MINimum?
FETCh:SUMMary:OSTP[:AVERage]?

This command queries the OSTP.

Return values:

<OSTP> <numeric value>

Minimum, maximum or average OSTP, depending on the last command syntax element.

Default unit: dBm

Example: `FETC:SUMM:OSTP?`

Returns the current average OSTP value.

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:POWer:MAXimum?
FETCh:SUMMary:POWer:MINimum?
FETCh:SUMMary:POWer[:AVERage]?

This command queries the total power.

Return values:

<Power> <numeric value>

Minimum, maximum or average power, depending on the last command syntax element.

Default unit: dBm

Example: `FETC:SUMM:POW?`

Returns the total power in dBm

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:QUADerror:MAXimum?
FETCh:SUMMary:QUADerror:MINimum?
FETCh:SUMMary:QUADerror[:AVERage]?

This command queries the quadrature error.

Return values:

<QuadError> <numeric value>

Minimum, maximum or average quadrature error, depending on the last command syntax element.

Default unit: deg

Example: `FETC:SUMM:QUAD?`
Returns the current mean quadrature error in degrees.

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:RSTP:MAXimum?
FETCh:SUMMary:RSTP:MINimum?
FETCh:SUMMary:RSTP[:AVERage]?

This command queries the RSTP as shown in the result summary.

Return values:

<RSTP> RSTP in dBm.

Example: `FETC:SUMM:RSTP?`
Queries the RSTP.

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:SERRor:MAXimum?
FETCh:SUMMary:SERRor:MINimum?
FETCh:SUMMary:SERRor[:AVERage]?

This command queries the sampling error.

Return values:

<SamplingError> <numeric value>

Minimum, maximum or average sampling error, depending on the last command syntax element.

Default unit: ppm

Example: `FETC:SUMM:SERR?`
Returns the current mean sampling error in ppm.

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:TAE<antenna>?

This command queries the time alignment error.

Suffix:
<antenna> 2..4
Number of the antenna you want to compare to antenna 1.

Return values:
<TimeAlignError>
Time alignment error of antenna 1 and another antenna.

Usage: Query only

Manual operation: See "Result Summary" on page 28

FETCh:SUMMary:TFRame?

This command queries the (sub)frame start offset as shown in the Capture Buffer result display.

Return values:
<Offset> Time difference between the (sub)frame start and capture buffer start.
Default unit: s

Example: `FETC:SUMM:TFR?`
Returns the (sub)frame start offset.

Usage: Query only

Manual operation: See "Capture Buffer" on page 31

8.6 Remote Commands to Read Trace Data

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8.6.1 Using the TRACe[:DATA] Command

This chapter contains information on the TRACe:DATA command and a detailed description of the characteristics of that command.

The TRACe:DATA command queries the trace data or results of the currently active measurement or result display. The type, number and structure of the return values are specific for each result display. In case of results that have any kind of unit, the command returns the results in the unit you have currently set for that result display.

Note also that return values for results that are available for both downlink and uplink may be different.

For several result displays, the command also supports various SCPI parameters in combination with the query. If available, each SCPI parameter returns a different aspect of the results. If SCPI parameters are supported, you have to quote one in the query.

Example:

```
TRAC2:DATA? TRACE1
```

The format of the return values is either in ASCII or binary characters and depends on the format you have set with `FORMat[:DATA]`.

Following this detailed description, you will find a short summary of the most important functions of the command (`TRACe[:DATA]?`).

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8.6.1.1 Adjacent Channel Leakage Ratio

For the ACLR result display, the number and type of returns values depend on the parameter.

- TRACE1
  Returns one value for each trace point.
- LIST
  Returns the contents of the ACLR table.
  For each channel, it returns six values.
  `<channel type>, <bandwidth>, <spacing offset>, <power of lower channel>, <power of upper channel>, <limit>, ...`
  The unit of the `<bandwidth>` and `<spacing offset>` is Hz.
  The unit of the power values is either dBm for the TX channel or dB for the neighboring channels.

The unit of the limit is dB.
The <channel type> is encoded. For the code assignment see chapter 8.6.1.19, "Return Value Codes", on page 113.
Note that the TX channel does not have a <spacing offset>, <power of lower channel> and <limit>. NaN is returned instead.

8.6.1.2 Allocation Summary

For the Allocation Summary, the command returns seven values for each line of the table.

<subframe>, <allocation ID>, <number of RB>, <relative power>, <modulation>, <absolute power>, <EVM>, ...

The unit for <absolute power> is always dBm. The unit for <relative power> is always dB. The unit for <EVM> depends on UNIT:EVM. All other values have no unit.

The <allocation ID> and <modulation> are encoded. For the code assignment see chapter 8.6.1.19, "Return Value Codes", on page 113.

Note that the data format of the return values is always ASCII.

Example:

Allocation Summary — Selection: Antenna 1

Sub-frame	Alloc. ID	Number of RB	Rel. Power/dB	Modulation	Power per RE/dBm	EVM/%
0	RS Ant1		0,000	QPSK	-45,546	0,733
	P-SYNC		-0,007	CAZAC	-42,558	0,254
	S-SYNC		0,005	RBPSK	-42,546	0,251

TRAC:DATA? TRACE1 would return:

```
0, -5, 0, 0.0000000000000, 2, -45.5463829153428, 7.33728660354122E-05,
0, -3, 0, 0.0073997452251, 6, -42.5581007463452, 2.54197349219455E-05,
0, -4, 0, 0.0052647197362, 1, -42.5464220485716, 2.51485275782241E-05,
...
```

8.6.1.3 Bit Stream

For the Bit Stream result display, the command returns five values and the bitstream for each line of the table.

<subframe>, <allocation ID>, <codeword>, <modulation>, <# of symbols/bits>, <hexadecimal/binary numbers>,...

All values have no unit. The format of the bitstream depends on Bit Stream Format.

The <allocation ID>, <codeword> and <modulation> are encoded. For the code assignment see chapter 8.6.1.19, "Return Value Codes", on page 113.

For symbols or bits that are not transmitted, the command returns

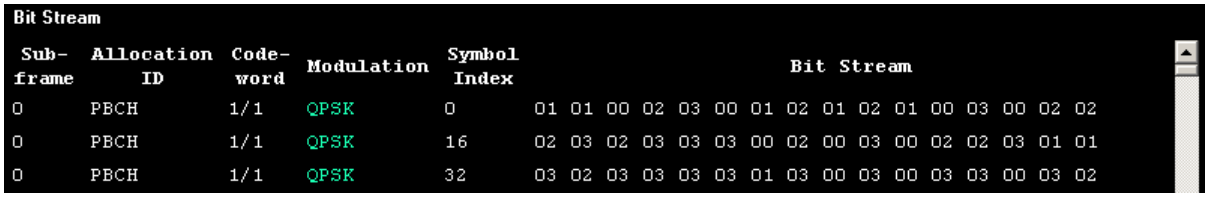
- "FF" if the bit stream format is "Symbols"
- "9" if the bit stream format is "Bits".

For symbols or bits that could not be decoded because the number of layer exceeds the number of receive antennas, the command returns

- "FE" if the bit stream format is "Symbols"
- "8" if the bit stream format is "Bits".

Note that the data format of the return values is always ASCII.

Example:



`TRAC:DATA? TRACE1` would return:

```
0, -12, 0, 2, 0, 01, 01, 00, 02, 03, 00, 01, 02, 01, 02, 01, ...
<continues like this until the next data block starts or the end of data is reached>
0, -12, 0, 2, 32, 03, 02, 03, 03, 03, 03, 01, 03, 00, 03, ...
```

8.6.1.4 Capture Buffer

For the Capture Buffer result display, the command returns one value for each I/Q sample in the capture buffer.

`<absolute power>, ...`

The unit is always dBm.

The following parameters are supported.

- TRACE1

8.6.1.5 CCDF

For the CCDF result display, the type of return values depends on the parameter.

- TRACE1
  Returns the probability values (y-axis).
  `<# of values>, <probability>, ...`
  The unit is always %.
  The first value that is returned is the number of the following values.
- TRACE2
  Returns the corresponding power levels (x-axis).
  `<# of values>, <relative power>, ...`
  The unit is always dB.
  The first value that is returned is the number of the following values.

8.6.1.6 Channel Flatness

For the Channel Flatness result display, the command returns one value for each trace point.

```
<relative power>, ...
```

The unit is always dB.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

8.6.1.7 Channel Flatness Difference

For the Channel Flatness Difference result display, the command returns one value for each trace point.

```
<relative power>, ...
```

The unit is always dB. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

8.6.1.8 Channel Group Delay

For the Channel Group Delay result display, the command returns one value for each trace point.

```
<group delay>, ...
```

The unit is always ns. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the group delay.

8.6.1.9 Constellation Diagram

For the Constellation Diagram, the command returns two values for each constellation point.

<I[SF0][Symb0][Carrier1]>, <Q[SF0][Symb0][Carrier1]>, ..., <I[SF0][Symb0][Carrier(n)]>, <Q[SF0][Symb0][Carrier(n)]>,
<I[SF0][Symb1][Carrier1]>, <Q[SF0][Symb1][Carrier1]>, ..., <I[SF0][Symb1][Carrier(n)]>, <Q[SF0][Symb1][Carrier(n)]>,
<I[SF0][Symb(n)][Carrier1]>, <Q[SF0][Symb(n)][Carrier1]>, ..., <I[SF0][Symb(n)][Carrier(n)]>, <Q[SF0][Symb(n)][Carrier(n)]>,
<I[SF1][Symb0][Carrier1]>, <Q[SF1][Symb0][Carrier1]>, ..., <I[SF1][Symb0][Carrier(n)]>, <Q[SF1][Symb0][Carrier(n)]>,
<I[SF1][Symb1][Carrier1]>, <Q[SF1][Symb1][Carrier1]>, ..., <I[SF1][Symb1][Carrier(n)]>, <Q[SF1][Symb1][Carrier(n)]>,
<I[SF(n)][Symb(n)][Carrier1]>, <Q[SF(n)][Symb(n)][Carrier1]>, ..., <I[SF(n)][Symb(n)][Carrier(n)]>, <Q[SF(n)][Symb(n)][Carrier(n)]>

With SF = subframe and Symb = symbol of that subframe.

The I and Q values have no unit.

The number of return values depends on the constellation selection. By default, it returns all resource elements including the DC carrier.

The following parameters are supported.

- TRACE1
  Returns all constellation points included in the selection.

8.6.1.10 EVM vs Carrier

For the EVM vs Carrier result display, the command returns one value for each subcarrier that has been analyzed.

`<EVM>, ...`

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1
  Returns the average EVM over all subframes
- TRACE2
  Returns the minimum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.

8.6.1.11 EVM vs Symbol

For the EVM vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

```
<EVM>, ...
```

For measurements on a single subframe, the command returns the symbols of that subframe only.

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

8.6.1.12 EVM vs Subframe

For the EVM vs Subframe result display, the command returns one value for each subframe that has been analyzed.

```
<EVM>, ...
```

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

8.6.1.13 Frequency Error vs Symbol

For the Frequency Error vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

```
<frequency error>,...
```

The unit is always Hz.

The following parameters are supported.

- TRACE1

8.6.1.14 On/Off Power

For the On/Off Power measurement, the number and type of return values depend on the parameter.

- TRACE1
  Returns the power for the Off power regions.
  `<absolute power>,...`
  The unit is always dBm.
- TRACE2
  Returns the power for the transient regions.
  `<absolute power>,...`
  The unit is always dBm.

- LIST
  Returns the contents of the On/Off Power table. For each line, it returns seven values. `<off period start limit>, <off period stop limit>, <time at delta to limit>, <absolute off power>, <distance to limit>, <falling transient period>, <rising transient period>,...`
  The unit for the `<absolute off power>` is dBm. The unit for the `<distance to limit>` is dB. The unit for the `<transient periods>` is µs. All other values have the unit s.

8.6.1.15 Power Spectrum

For the Power Spectrum result display, the command returns one value for each trace point.

`<power>,...`

The unit is always dBm/Hz.

The following parameters are supported.

- TRACE1

8.6.1.16 Power vs RB RS

For the Power vs RB RS, the command returns one value for each resource block of the reference signal that has been analyzed.

`<absolute power>,...`

The unit is always dBm.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

8.6.1.17 Power vs RB PDSCH

For the Power vs RB PDSCH, the command returns one value for each resource block of the PDSCH that has been analyzed.

`<absolute power>,...`

The unit is always dBm.

The following parameters are supported.

- TRACE1

Returns the average power over all subframes

- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

8.6.1.18 Spectrum Emission Mask

For the SEM measurement, the number and type of returns values depend on the parameter.

- TRACE1
  Returns one value for each trace point.
  `<absolute power>, ...`
  The unit is always dBm.
- LIST
  Returns the contents of the SEM table. For every frequency in the spectrum emission mask, it returns 11 values.
  `<index>, <start frequency in Hz>, <stop frequency in Hz>, <RBW in Hz>, <limit fail frequency in Hz>, <absolute power in dBm>, <relative power in dBc>, <limit distance in dB>, <limit check result>, <reserved>, <reserved>...`
  The `<limit check result>` is either a 0 (for PASS) or a 1 (for FAIL).

8.6.1.19 Return Value Codes

This chapter contains a list for encoded return values.

<ACK/NACK>

The range is {-1...1}.

- **1** = ACK
- **0** = NACK
- **-1** = DTX

<allocation ID>

Represents the allocation ID. The range is {-13...65535}.

- **0 - 65535** = PDSCH
- **-1** = Invalid
- **-2** = All
- **-3** = P-SYNC
- **-4** = S-SYNC
- **-5** = PILOTS_ANT1
- **-6** = PILOTS_ANT2

- **-7** = PILOTS_ANT3
- **-8** = PILOTS_ANT4
- **-9** = PCFICH
- **-10** = PHICH
- **-11** = PDCCH
- **-12** = PBCH
- **-13** = PMCH

<channel type>

- **0** = TX channel
- **1** = adjacent channel
- **2** = alternate channel

<codeword>

Represents the codeword of an allocation. The range is {0...2}.

- **0** = 1/1
- **1** = 1/2
- **2** = 2/2

<DCI format>

Represents the DCi format. The value is a number in the range {0...103}.

- **0** = DCI format 0
- **10** = DCI format 1
- **11** = DCI format 1A
- **12** = DCI format 1B
- **13** = DCI format 1C
- **14** = DCI format 1D
- **20** = DCI format 2
- **21** = DCI format 2A
- **22** = DCI format 2B
- **23** = DCI format 2C
- **30** = DCI format 3
- **31** = DCI format A
- **103** = DCI format 0/3/3A

<modulation>

Represents the modulation scheme. The range is {0...8}.

- **0** = unrecognized
- **1** = RBPSK
- **2** = QPSK
- **3** = 16QAM

- **4** = 64QAM
- **5** = 8PSK
- **6** = PSK
- **7** = mixed modulation
- **8** = BPSK

<number of symbols or bits>

In hexadecimal mode, this represents the number of symbols to be transmitted. In binary mode, it represents the number of bits to be transmitted.

<PHICH duration>

Represents the PHICH duration. The range is {1...2}.

- **1** = normal
- **2** = extended

<PHICH resource>

Represents the parameter N_g. The range is {1...4}.

- **1** = N_g 1/6
- **2** = N_g 1/2
- **3** = N_g 1
- **4** = N_g 2

TRACe[:DATA]? <Result>

This command returns the trace data for the current measurement or result display.

For more information see chapter 8.6.1, "Using the TRACe[:DATA] Command", on page 105.

Query parameters:

<TraceNumber> **TRACE1 | TRACE2 | TRACE3**

LIST

PBCH

PCFICH

PHICH

PDCCH

Usage: Query only

8.6.2 Remote Commands to Read Measurement Results

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?....116
CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult?....116
CALCulate<n>:LIMit<k>:OOPower:OFFPower?....117
CALCulate<n>:LIMit<k>:OOPower:TRANsient?....117
CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?....118

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult? <Result>

This command queries the limit check results for the adjacent channels during ACLR measurements.

Query parameters:

<Result>

ALL
Queries the overall limit check results.

REL
Queries the channel power limit check results.

ABS
Queries the distance to the limit line.

Return values:

<LimitCheck>

Returns two values, one for the upper and one for the lower adjacent channel.

1
Limit check has passed.

0
Limit check has failed.

Example:

```
CALC:LIM:ACP:ACH:RES? ALL
```

Queries the results of the adjacent channel limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult? <Result>

This command queries the limit check results for the alternate channels during ACLR measurements.

Query parameters:

<Result>

ALL
Queries the overall limit check results.

REL
Queries the channel power limit check results.

ABS
Queries the distance to the limit line.

Return values:

<LimitCheck> Returns two values, one for the upper and one for the lower alternate channel.

1
Limit check has passed.

0
Limit check has failed.

Example: `CALC:LIM:ACP:ALT:RES? ALL`
Queries the results of the alternate channel limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:OOPower:OFFPower?

This command queries the results of the limit check in the "Off" periods of On/Off Power measurements.

Return values:

<OOPResults> Returns one value for every "Off" period.

1
Limit check has passed.

0
Limit check has failed.

Example: `CALC:LIM:OOP:OFFP?`
Queries the results for the limit check during the signal Off periods.

Usage: Query only

Manual operation: See "On / Off Power" on page 32

CALCulate<n>:LIMit<k>:OOPower:TRANsient?

This command queries the results of the limit check during the transient periods of the On/Off power measurement.

Query parameters:

<Result> **ALL**
Queries the overall limit check results.

FALLing
Queries the limit check results of falling transients.

RISing
Queries the limit check results of rising transients.

Return values:

<OOPResults> Returns one value for every "Off" period.

1
Limit check has passed.

0
Limit check has failed.

Example: `CALC:LIM:OOP:TRAN? RIS`
Queries the limit check of rising transients.

Usage: Query only

Manual operation: See "On / Off Power" on page 32

CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?

This command queries the current results of the ACLR measurement or the total signal power level of the SEM measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Suffix:
<m> 1

Query parameters:
CPOW This parameter queries the signal power of the SEM measurement.

Return values:
<Result>

SEMResults
Power level in dBm.

ACLRResults
Relative power levels of the ACLR channels. The number of return values depends on the number of transmission and adjacent channels. The order of return values is:
• <TXChannelPower> is the power of the transmission channel in dBm
• <LowerAdjChannelPower> is the relative power of the lower adjacent channel in dB
• <UpperAdjChannelPower> is the relative power of the upper adjacent channel in dB
• <1stLowerAltChannelPower> is the relative power of the first lower alternate channel in dB
• <1stUpperAltChannelPower> is the relative power of the first lower alternate channel in dB
(...)
• <nthLowerAltChannelPower> is the relative power of a subsequent lower alternate channel in dB
• <nthUpperAltChannelPower> is the relative power of a subsequent lower alternate channel in dB

Example: `CALC1:MARK:FUNC:POW:RES?`
Returns the current ACLR measurement results.

Usage: Query only

Manual operation: See "ACLR" on page 40

8.7 Remote Commands to Configure the Application

- Remote Commands for General Settings....119
- Configuring MIMO Setups....127
- Advanced General Settings....128
- Configuring Downlink Signal Demodulation....130
- Configuring Downlink Frames....134
- Defining Advanced Signal Characteristics....138

8.7.1 Remote Commands for General Settings

This chapter contains remote control commands necessary to control the general measurement settings.

For more information see chapter 5.2, "General Settings", on page 49.

8.7.1.1 Defining Signal Characteristics

CONFigure[:LTE]:DL:BW....119
CONFigure[:LTE]:DL:CYCPrefix....119
CONFigure[:LTE]:DL:NORB....120
CONFigure[:LTE]:DUPLexing....120
CONFigure[:LTE]:LDIRection....120
[SENSe]:FREQuency:CENTer....121

CONFigure[:LTE]:DL:BW <Bandwidth>

This command selects the downlink bandwidth.

Parameters:

<Bandwidth> BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 | BW20_00

*RST: BW10_00

Example: `CONF:DL:BW BW1_40`
Sets a signal bandwidth of 1.4 MHz in downlink.

Manual operation: See "Channel Bandwidth / Number of Resource Blocks" on page 50

CONFigure[:LTE]:DL:CYCPrefix <PrefixLength>

This command selects the cyclic prefix for downlink signals.

Parameters:

<PrefixLength>

NORM
Normal cyclic prefix length

EXT
Extended cyclic prefix length

AUTO
Automatic cyclic prefix length detection

*RST: AUTO

Example: `CONF:DL:CYCP EXT`
Sets cyclic prefix type to extended.

Manual operation: See "Cyclic Prefix" on page 51

CONFigure[:LTE]:DL:NORB <ResourceBlocks>

This command selects the number of resource blocks for downlink signals.

Parameters:

<ResourceBlocks> <numeric value>

*RST: 50

Example: `CONF:DL:NORB 25`
Sets the number of resource blocks to 25.

Manual operation: See "Channel Bandwidth / Number of Resource Blocks" on page 50

CONFigure[:LTE]:DUPLexing <Duplexing>

This command selects the duplexing mode.

Parameters:

<Duplexing>

TDD
Time division duplex

FDD
Frequency division duplex

*RST: FDD

Example: `CONF:DUPL TDD`
Activates time division duplex.

Manual operation: See "Selecting the LTE Mode" on page 50

CONFigure[:LTE]:LDIRection <Direction>

This command selects the link direction

Parameters:

<Direction>

DL
Downlink

UL
Uplink

Example: `CONF:LDIR DL`
EUTRA/LTE option is configured to analyze downlink signals.

Manual operation: See "Selecting the LTE Mode" on page 50

[SENSe]:FREQuency:CENTer <Frequency>

This command sets the center frequency for RF measurements.

Parameters:

<Frequency>

<numeric value>

Range: fmin to fmax
*RST: 1 GHz
Default unit: Hz

Example: `FREQ:CENT 2GHZ`
Set the center frequency to 2 GHz.

Manual operation: See "Defining the Signal Frequency" on page 50

8.7.1.2 Configuring the Input Level

CONFigure:POWer:EXPected:IQ<analyzer>....121
CONFigure:POWer:EXPected:RF<analyzer>....122
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet....122
INPut<n>:ATTenuation<analyzer>....122
INPut<n>:EATT....122
INPut<n>:EATT:STATe....123
INPut<n>:EATT:AUTO....123
[SENSe]:POWer:AUTO<analyzer>[:STATe]....123
[SENSe]:POWer:AUTO<analyzer>:TIME....124

CONFigure:POWer:EXPected:IQ<analyzer> <RefLevel>

This command defines the reference level when the input source is baseband.

Parameters:

<RefLevel>

<numeric value>

Range: 31.6 mV to 5.62 V
*RST: 1 V
Default unit: V

Example: `CONF:POW:EXP:IQ2 3.61`
Sets the baseband-reference level used by analyzer 2 to 3.61 V.

Manual operation: See "Defining a Reference Level" on page 52

CONFigure:POWer:EXPected:RF<analyzer> <RefLevel>

This command defines the reference level when the input source is RF.

Parameters:

<RefLevel> *RST: -30 dBm
Default unit: DBM

Example: `CONF:POW:EXP:RF3 -20`
Sets the radio frequency reference level used by analyzer 3 to -20 dBm.

Manual operation: See "Defining a Reference Level" on page 52

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Attenuation>

This command selects the external attenuation or gain applied to the RF signal.

Parameters:

<Attenuation> <numeric value>
*RST: 0
Default unit: dB

Example: `DISP:TRAC:Y:RLEV:OFFS 10`
Sets an external attenuation of 10 dB.

Manual operation: See "Attenuating the Signal" on page 52

INPut<n>:ATTenuation<analyzer> <Attenuation>

This command sets the RF attenuation level.

Parameters:

<Attenuation> <numeric value>
*RST: 5 dB
Default unit: dB

Example: `INP:ATT 10`
Defines an RF attenuation of 10 dB.

Manual operation: See "Attenuating the Signal" on page 52

INPut<n>:EATT <Attenuation>

This command defines the electronic attenuation level.

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

This command is available with option R&S FSV-B25, but not if R&S FSV-B17 is active.

Parameters:

<Attenuation> Attenuation level in dB.
Default unit: dB

Example: `INP:EATT 10`
Defines an attenuation level of 10 dB.

INPut<n>:EATT:STATe <State>

This command turns the electronic attenuator on and off.

This command is available with option R&S FSV-B25, but not if R&S FSV-B17 is active.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `INP:EATT:STAT ON`
Turns the electronic attenuator on.

INPut<n>:EATT:AUTO <State>

This command turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

This command is available with option R&S FSV-B25, but not if R&S FSV-B17 is active.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `INP:EATT:AUTO ON`
Turns automatic selection of electronic attenuation level on.

[SENSe]:POWer:AUTO<analyzer>[:STATe] <State>

This command initiates a measurement that determines the ideal reference level.

Parameters:
<State> **OFF**
Performs no automatic reference level detection.

ON
Performs an automatic reference level detection before each measurement.

ONCE
Performs an automatic reference level once.

*RST: ON

Example: `POW:AUTO2 ON`
Activate auto level for analyzer number 2.

Manual operation: See "Auto Level" on page 49
See "Defining a Reference Level" on page 52

[SENSe]:POWer:AUTO<analyzer>:TIME <Time>

This command defines the track time for the auto level process.

Parameters:

<Time> <numeric value>

*RST: 100 ms
Default unit: s

Example: `POW:AUTO:TIME 200ms`
An auto level track time of 200 ms gets set.

Manual operation: See "Defining a Reference Level" on page 52

8.7.1.3 Configuring the Data Capture

[SENSe][:LTE]:FRAMe:COUNt....124
[SENSe][:LTE]:FRAMe:COUNt:AUTO....124
[SENSe][:LTE]:FRAMe:COUNt:STATe....125
[SENSe]:SWEep:TIME....125

[SENSe][:LTE]:FRAMe:COUNt <Subframes>

This command sets the number of frames you want to analyze.

Parameters:

<Subframes> <numeric value>

*RST: 1

Example: `FRAM:COUN:STAT ON`
Activates manual input of frames to be analyzed.
`FRAM:COUN 20`
Analyzes 20 frames.

Manual operation: See "Number of Frames to Analyze" on page 54

[SENSe][:LTE]:FRAMe:COUNt:AUTO <State>

This command turns automatic selection of the number of frames to analyze on and off.

Parameters:

<State> **ON**
Selects the number of frames to analyze according to the LTE standard.

OFF
Turns manual selection of the frame number on.

Example: `FRAM:COUN:AUTO ON`
Turns automatic selection of the analyzed frames on.

Manual operation: See "Auto According to Standard" on page 54

[SENSe][:LTE]:FRAMe:COUNt:STATe <State>

This command turns manual selection of the number of frames you want to analyze on and off.

Parameters:

<State>
ON
You can set the number of frames to analyze.
OFF
The R&S FSV analyzes a single sweep.
*RST: ON

Example: `FRAM:COUN:STAT ON`
Turns manual setting of number of frames to analyze on.

Manual operation: See "Overall Frame Count" on page 53

[SENSe]:SWEep:TIME <CaptLength>

This command sets the capture time.

Parameters:

<CaptLength> Numeric value in seconds.
Default unit: s

Example: `SWE:TIME 40`
Defines a capture time of 40 seconds.

Manual operation: See "Capture Time" on page 53

8.7.1.4 Configuring On/Off Power Measurements

CONFigure[:LTE]:OOPower:NFRames....125
[SENSe][:LTE]:OOPower:NCORrection....125

CONFigure[:LTE]:OOPower:NFRames <Frames>

This command defines the number of frames that are analyzed for On/Off Power measurements.

Parameters:

<Frames> <numeric value>

Example: `CONF:OOP:NFR 10`
Defines 10 frames to be analyzed.

Manual operation: See "Number of Frames" on page 54

[SENSe][:LTE]:OOPower:NCORrection <NoiseCorrection>

This command turns noise correction for On/Off Power measurements on and off.

Parameters:
<NoiseCorrection> ON | OFF

Manual operation: See "Noise Correction" on page 54

8.7.1.5 Triggering Measurements

TRIGger[:SEQuence]:HOLDoff<analyzer>....126
TRIGger[:SEQuence]:IFPower:HOLDoff....126
TRIGger[:SEQuence]:IFPower:HYSTeresis....126
TRIGger[:SEQuence]:LEVel<analyzer>:POWer....127
TRIGger[:SEQuence]:MODE....127

TRIGger[:SEQuence]:HOLDoff<analyzer> <Offset>

This command defines the trigger offset.

Parameters:
<Offset> <numeric value>
*RST: 0 s
Default unit: s

Example: `TRIG:HOLD 5MS`
Sets the trigger offset to 5 ms.

TRIGger[:SEQuence]:IFPower:HOLDoff <Offset>

This command defines the holding time before the next trigger event.

Note that this command is available for **any trigger source**, not just IF Power.

Parameters:
<Offset> Range: 150 ns to 10 s
*RST: 150 ns
Default unit: s

Example: `TRIG:IFP:HOLD 1`
Defines a holdoff of 1 second.

TRIGger[:SEQuence]:IFPower:HYSTeresis <Hysteresis>

This command defines the trigger hysteresis.

Parameters:
<Hysteresis> Range: 3 to 50
*RST: 3
Default unit: dB

Example: `TRIG:IFP:HYST 10`
Defines a trigger hysteresis of 10 dB.

TRIGger[:SEQuence]:LEVel<analyzer>:POWer <Level>

This command defines the trigger level for an IF power trigger.

Parameters:

<Level> Default unit: DBM

Example: `TRIG:LEV:POW 10`
Defines a trigger level of 10 dBm.

TRIGger[:SEQuence]:MODE <Source>

This command selects the trigger source.

Parameters:

<Source>

EXTernal
Selects external trigger source.

IFPower
Selects the IF power trigger source.

IMMediate
Selects free run trigger source.

PSEN
Selects power sensor trigger source.

RFPower
Selects RF power trigger source.

*RST: IMMediate

Example: `TRIG:MODE EXT`
Selects an external trigger source.

8.7.2 Configuring MIMO Setups

CONFigure[:LTE]:DL:MIMO:ASELection....127
CONFigure[:LTE]:DL:MIMO:CONFig....128

CONFigure[:LTE]:DL:MIMO:ASELection <Antenna>

This command selects the antenna for measurements with MIMO setups.

Parameters:

<Antenna>

ANT1 | ANT2 | ANT3 | ANT4
Select a single antenna to be analyzed

*RST: ANT1

Example: `CONF:DL:MIMO:ASEL ANT3`
Selects antenna 3 to be analyzed.

Manual operation: See "MIMO Configuration" on page 56

CONFigure[:LTE]:DL:MIMO:CONFig <NofAntennas>

This command sets the number of antennas in the MIMO setup.

Parameters:

<NofAntennas>
TX1
Use one Tx-antenna
TX2
Use two Tx-antennas
TX4
Use four Tx-antennas
*RST: TX1

Example: `CONF:DL:MIMO:CONF TX2`
TX configuration with two antennas is selected.

Manual operation: See "MIMO Configuration" on page 56

8.7.3 Advanced General Settings

8.7.3.1 Controlling I/Q Data

[SENSe]:SWAPiq....128

[SENSe]:SWAPiq <State>

This command turns a swap of the I and Q branches on and off.

Parameters:

<State>
ON | OFF
*RST: OFF

Example: `SWAP ON`
Turns a swap of the I and Q branches on.

Manual operation: See "Swap I/Q" on page 60

8.7.3.2 Controlling the Input

For information on the remote commands for reference level and attenuation settings see chapter 8.7.1.2, "Configuring the Input Level", on page 121.

INPut:SELect....128
TRACe:IQ:FILTer:FLATness....129

INPut:SELect <Source>

This command selects the signal source.

Parameters:

<Source>

RF
Selects the RF input as the signal source.

AIQ
Selects the analog baseband input as the data source. This source is available only with option R&S FSV-B71.

DIQ
Selects the digital baseband input as the data source. This source is available only with option R&S FSV-B17.

Example: `INP DIQ`
Selects the digital baseband input.

Manual operation: See "Selecting the Input Source" on page 60

TRACe:IQ:FILTer:FLATness <FilterType>

This command turns the wideband filter on and off.

Parameters:

<FilterType>

NORMal
Uses the normal filter.

WIDE
Turns the wideband filter on.

*RST: NORMal

Example: `TRAC:IQ:FILT:FLAT WIDE`
Turns the wideband filter on.

8.7.3.3 Configuring the Digital I/Q Input

INPut<n>:DIQ:SRATe....129
INPut<n>:DIQ:RANGe[:UPPer]....129

INPut<n>:DIQ:SRATe <SampleRate>

This command defines the sampling rate for a digital I/Q signal source.

Parameters:

<SampleRate>

*RST: 10 MHz
Default unit: Hz

Example: `INP:DIQ:SRAT 10MHZ`
Defines a sampling rate of 10 MHz.

Manual operation: See "Sampling Rate (Input Data Rate)" on page 61

INPut<n>:DIQ:RANGe[:UPPer] <ScaleLevel>

This command defines the full scale level for a digital I/Q signal source.

Parameters:
<ScaleLevel> *RST: 1 V
Default unit: V

Example: `INP:DIQ:RANG 0.7`
Sets the full scale level to 0.7 V.

Manual operation: See "Full Scale Level" on page 61

8.7.4 Configuring Downlink Signal Demodulation

8.7.4.1 Configuring the Data Analysis

[SENSe][:LTE]:DL:DEMod:AUTO....130
[SENSe][:LTE]:DL:DEMod:BESTimation....130
[SENSe][:LTE]:DL:DEMod:CBSCrambling....131
[SENSe][:LTE]:DL:DEMod:CESTimation....131
[SENSe][:LTE]:DL:DEMod:EVMCalc....131
[SENSe][:LTE]:DL:DEMod:MCFilter....131
[SENSe][:LTE]:DL:DEMod:PRData....132
[SENSe][:LTE]:DL:FORMat:PSCD....132

[SENSe][:LTE]:DL:DEMod:AUTO <State>

This command turns automatic demodulation for downlink signals on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `DL:DEM:AUTO ON`
Activates the auto-demodulation for DL.

Manual operation: See "Auto PDSCH Demodulation" on page 63

[SENSe][:LTE]:DL:DEMod:BESTimation <State>

This command turns boosting estimation for downlink signals on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `DL:DEM:BEST ON`
Turns boosting estimation on.

Manual operation: See "Boosting Estimation" on page 64

[SENSe][:LTE]:DL:DEMod:CBSCrambling <State>

This command turns scrambling of coded bits for downlink signals on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `DL:DEM:CBSC ON`
Activate scrambling of coded bits.

Manual operation: See "Scrambling of Coded Bits" on page 62

[SENSe][:LTE]:DL:DEMod:CESTimation <Type>

This command selects the channel estimation type for downlink signals.

Parameters:

<Type> **TGPP**
3GPP EVM definition

PIL
Optimal, pilot only

PILP
Optimal, pilot and payload

*RST: TGPP

Example: `DL:DEM:CEST TGPP`
Use 3GPP EVM definition for channel estimation.

Manual operation: See "Channel Estimation" on page 62

[SENSe][:LTE]:DL:DEMod:EVMCalc <Calculation>

This command selects the EVM calculation method for downlink signals.

Parameters:

<Calculation> **TGPP**
3GPP definition

OTP
Optimal timing position

*RST: TGPP

Example: `DL:DEM:EVMC TGPP`
Use 3GPP method.

Manual operation: See "EVM Calculation Method" on page 62

[SENSe][:LTE]:DL:DEMod:MCFilter <State>

This command turns suppression of interfering neighboring carriers on and off (e.g. LTE, WCDMA, GSM etc).

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DL:DEM:MCF ON`
Turns suppression on of neighboring carriers on.

Manual operation: See "Multicarrier Filter" on page 64

[SENSe][:LTE]:DL:DEMod:PRData <Reference>

This command the type of reference data to calculate the EVM for the PDSCH.

Parameters:

<Reference>

AUTO
Automatic identification of reference data.

ALL0
Reference data is 0, according to the test model definition.

Example: `DL:DEM:PRD ALL0`
Sets the reference data of the PDSCH to 0.

Manual operation: See "PDSCH Reference Data" on page 64

[SENSe][:LTE]:DL:FORMat:PSCD <Format>

This command selects the method of identifying the PDSCH resource allocation.

Parameters:

<Format>

OFF
Applies the user configuration of the PDSCH subframe regardless of the signal characteristics.

PDCCH
Identifies the configuration according to the data in the PDCCH DCIs.

PHYDET
Manual PDSCH configuration: analysis only if the actual subframe configuration matches the configured one.
Automatic PDSCH configuration: physical detection of the configuration.

*RST: PHYD

Example: `DL:FORM:PSCD OFF`
Applies the user configuration and does not check the received signal

Manual operation: See "PDSCH Subframe Configuration Detection" on page 63

8.7.4.2 Compensating Measurement Errors

[SENSe][:LTE]:DL:TRACking:PHASe....133
[SENSe][:LTE]:DL:TRACking:TIME....133

[SENSe][:LTE]:DL:TRACking:PHASe <Type>

This command selects the phase tracking type for downlink signals.

Parameters:

<Type>
OFF
Deactivate phase tracking
PIL
Pilot only
PILP
Pilot and payload
*RST: OFF

Example: `DL:TRAC:PHAS PILPAY`
Use pilots and payload for phase tracking.

Manual operation: See "Phase" on page 65

[SENSe][:LTE]:DL:TRACking:TIME <State>

This command turns timing tracking for downlink signals on and off.

Parameters:

<State>
ON | OFF
*RST: OFF

Example: `DL:TRAC:TIME ON`
Activates timing tracking.

Manual operation: See "Timing" on page 65

8.7.4.3 Configuring MIMO Setups

CONFigure[:LTE]:DL:MIMO:CROSstalk....133

CONFigure[:LTE]:DL:MIMO:CROSstalk <State>

This command turns MIMO crosstalk compensation on and off.

Parameters:

<State>
ON | OFF
*RST: OFF

Example: `CONF:DL:MIMO:CROS ON`
Turns crosstalk compensation on.

Manual operation: See "Compensate Crosstalk" on page 65

8.7.5 Configuring Downlink Frames

8.7.5.1 Configuring TDD Signals

CONFigure[:LTE]:DL:TDD:SPSC....134
CONFigure[:LTE]:DL:TDD:UDConf....134

CONFigure[:LTE]:DL:TDD:SPSC <Configuration>

Selects the configuration of a TDD special subframe.

Parameters:

<Configuration> <numeric value>

Numeric value that defines the subframe configuration. Subframe configurations 7 and 8 are only available if the cyclic prefix is normal.

Range: 0 to 8
*RST: 0

Example: `CONF:DL:CYCP NORM`
Selects normal cyclic prefix.
`CONF:DL:TDD:SPSC 7`
Selects subframe configuration 7, available only with a normal cyclic prefix.

Manual operation: See "Configuring TDD Frames" on page 66

CONFigure[:LTE]:DL:TDD:UDConf <Configuration>

This command selects the UL/DL subframe configuration for downlink signals.

Parameters:

<Configuration> Range: 0 to 6
*RST: 0

Example: `CONF:DL:TDD:UDC 2`
Selects allocation configuration number 2.

Manual operation: See "Configuring TDD Frames" on page 66

8.7.5.2 Configuring the Physical Layer Cell Identity

CONFigure[:LTE]:DL:PLC:CID....135
CONFigure[:LTE]:DL:PLC:CIDGroup....135
CONFigure[:LTE]:DL:PLC:PLID....135
FETCh:PLC:CIDGroup?....135
FETCh:PLC:PLID?....136

CONFigure[:LTE]:DL:PLC:CID <CellId>

This command defines the cell ID.

Parameters:

<CellId>

AUTO
Automatically defines the cell ID.

<numeric value>
Number of the cell ID.

Range: 0 to 503

Example:
```
CONF:DL:PLC:CID 12
```
Defines the cell ID 12.

CONFigure[:LTE]:DL:PLC:CIDGroup <GroupNumber>

This command selects the cell ID group for downlink signals.

Parameters:

<GroupNumber>

AUTO
Automatic selection

0...167
Manual selection

*RST: AUTO

Example:
```
CONF:DL:PLC:CIDG 134
```
Cell identity group number 134 is selected
```
CONF:DL:PLC:CIDG AUTO
```
Automatic cell identity group detection is selected

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 67

CONFigure[:LTE]:DL:PLC:PLID <Identity>

This command defines the physical layer cell identity for ownlink signals.

Parameters:

<Identity>

AUTO
Automatic selection

0...2
Manual selection

*RST: AUTO

Example:
```
CONF:DL:PLC:PLID 1
```
Selects physical layer cell ID 2.

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 67

FETCh:PLC:CIDGroup?

This command queries the cell identity group that has been detected.

Return values:

<CidGroup> The command returns -1 if no valid result has been detected yet.
Range: 0 to 167

Example: `FETC:PLC:CIDG?`
Returns the current cell identity group.

Usage: Query only

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 67

FETCh:PLC:PLID?

This command queries the cell identity that has been detected.

Return values:

<Identity> The command returns -1 if no valid result has been detected yet.
Range: 0 to 2

Example: `FETC:PLC:PLID?`
Returns the current cell identity.

Usage: Query only

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 67

8.7.5.3 Configuring PDSCH Subframes

CONFigure[:LTE]:DL:CSUBframes....136
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALCount....136
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]:
MODulation....137
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWer....137
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount....137
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOFfset....138

CONFigure[:LTE]:DL:CSUBframes <NofSubframes>

This command selects the number of configurable subframes in the downlink signal.

Parameters:

<NofSubframes> Range: 0 to 39
*RST: 1

Example: `CONF:DL:CSUB 5`
Sets the number of configurable subframes to 5.

Manual operation: See "Configuring PDSCH Allocations" on page 69

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALCount <NofAllocations>

This command defines the number of allocations in a downlink subframe.

Parameters:

<NofAllocations> <numeric value>

*RST: 1

Example: `CONF:DL:SUBF2:ALC 5`
Defines 5 allocations for subframe 2.

Manual operation: See "Configuring PDSCH Allocations" on page 69

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]:MODulation <Modulation>

This command selects the modulation of an allocation in a downlink subframe.

Suffix:

<Cwnum> 1..n
Selects the codeword.

Parameters:

<Modulation> **QPSK**
QPSK modulation

QAM16
16QAM modulation

QAM64
64QAM modulation

*RST: QPSK

Example: `CONF:DL:SUBF2:ALL5:CW2:MOD QAM64`
Selects a 64QAM modulation for the second codeword of allocation 5 in subframe 2.

Manual operation: See "Configuring PDSCH Allocations" on page 69

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWer <Power>

This command defines the (relative) power of an allocation in a downlink subframe.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:SUBF2:ALL5:POW -1.3`
Defines a relative power of 1.3 dB for allocation 5 in subframe 2.

Manual operation: See "Configuring PDSCH Allocations" on page 69

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount <ResourceBlocks>

This command selects the number of resource blocks of an allocation in a downlink subframe.

Parameters:
<ResourceBlocks> <numeric value>
*RST: 6

Example: `CONF:DL:SUBF2:ALL5:RBC 25`
Defines 25 resource block for allocation 5 in subframe 2.

Manual operation: See "Configuring PDSCH Allocations" on page 69

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOFfset <Offset>

This command defines the resource block offset of an allocation in a downlink subframe.

Parameters:
<Offset> <numeric value>
*RST: 0

Example: `CONF:DL:SUBF2:ALL5:RBOF 3`
Defines a resource block offset of 3 for allocation 5 in subframe 2.

Manual operation: See "Configuring PDSCH Allocations" on page 69

8.7.6 Defining Advanced Signal Characteristics

8.7.6.1 Defining the PDSCH Resource Block Symbol Offset

CONFigure[:LTE]:DL:PSOFfset.....138

CONFigure[:LTE]:DL:PSOFfset <Offset>

This command defines the symbol offset for PDSCH allocations relative to the start of the subframe.

The offset applies to all subframes.

Parameters:
<Offset> **AUTO**
Automatically determines the symbol offset.
<numeric value>
Manual selection of the symbol offset.
Range: 0 to 4
*RST: AUTO

Example: `CONF:DL:PSOF 2`
Sets an offset of 2 symbols.

Manual operation: See "PRB Symbol Offset" on page 72

8.7.6.2 Configuring the Reference Signal

CONFigure[:LTE]:DL:REFSig:POWer....139

CONFigure[:LTE]:DL:REFSig:POWer <Power>

This command defines the relative power of the reference signal.

Parameters:

<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example: `CONF:DL:REFS:POW -1.2`
Sets a relative power of -1.2 dB.

Manual operation: See "Rel Power (Reference Signal)" on page 72

8.7.6.3 Configuring the Synchronization Signal

CONFigure[:LTE]:DL:SYNC:ANTenna....139
CONFigure[:LTE]:DL:SYNC:PPOWer....139
CONFigure[:LTE]:DL:SYNC:SPOWer....140

CONFigure[:LTE]:DL:SYNC:ANTenna <Antenna>

This command selects the antenna that transmits the P-SYNC and the S-SYNC.

Parameters:

<Antenna> ANT1 | ANT2 | ANT3 | ANT4 | ALL | NONE
*RST: ALL

Example: `CONF:DL:SYNC:ANT ALL`
All antennas are used to transmit the P-SYNC and S-SYNC.

Manual operation: See "P-/S-SYNC Tx Antenna" on page 73

CONFigure[:LTE]:DL:SYNC:PPOWer <Power>

This command defines the relative power of the P-SYNC.

Parameters:

<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example: `CONF:DL:SYNC:PPOW 0.5`
Sets a relative power of 0.5 dB.

Manual operation: See "P-SYNC Relative Power" on page 73

CONFigure[:LTE]:DL:SYNC:SPOWer <Power>

This command defines the relative power of the S-SYNC.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:SYNC:SPOW 0.5`
Sets a relative power of 0.5 dB.

Manual operation: See "S-SYNC Relative Power" on page 73

8.7.6.4 Configuring the Control Channel

CONFigure[:LTE]:DL:PBCH:POWer....140
CONFigure[:LTE]:DL:PBCH:STAT....140
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CONFigure[:LTE]:DL:PHICh:NGParameter....143
CONFigure[:LTE]:DL:PHICh:NOGRoups....143
CONFigure[:LTE]:DL:PHICh:POWer....143

CONFigure[:LTE]:DL:PBCH:POWer <Power>

This command defines the relative power of the PBCH.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:PBCH:POW -1.1`
Sets the relative power to -1.1 dB.

Manual operation: See "PBCH Relative Power" on page 74

CONFigure[:LTE]:DL:PBCH:STAT <State>

This command turns the PBCH on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `CONF:DL:PBCH:STAT ON`
Activates the PBCH.

Manual operation: See "PBCH Present" on page 74

CONFigure[:LTE]:DL:PCFich:POWer <Power>

This command defines the relative power of the PCFICH.

Parameters:
<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example: `CONF:DL:PCF:POW 0`
Sets the relative power to 0 dB.

Manual operation: See "PCFICH Relative Power" on page 74

CONFigure[:LTE]:DL:PCFich:STAT <State>

This command turns the PCFICH on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `CONF:DL:PCF:STAT ON`
Activates the PCFICH.

Manual operation: See "PCFICH Present" on page 74

CONFigure[:LTE]:DL:PDCCh:FORMat <Format>

This command selects the PDCCH format.

Parameters:
<Format> -1 | 0 | 1 | 2 | 3
*RST: -1

Example: `CONF:DL:PDCCH:FORM 0`
Sets the PDDCH format to 0.

Manual operation: See "PDCCH Format" on page 76

CONFigure[:LTE]:DL:PDCCh:NOPD <NofPDCCH>

This command sets the number of PDCCHs.

Parameters:
<NofPDCCH> <numeric value>
*RST: 0

Example: `CONF:DL:PDCCH:NOPD 3`
Sets the number of DPCCHs to 3.

Manual operation: See "Number of PDCCHs" on page 76

CONFigure[:LTE]:DL:PDCCh:POWer <Power>

This command defines the relative power of the PDCCH.

Parameters:

<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example: `CONF:DL:PDCCH:POW -1.2`
Sets the relative power to -1.2 dB.

Manual operation: See "PDCCH Rel Power" on page 77

CONFigure[:LTE]:DL:PHICh:DURation <Duration>

This command selects the PHICH duration.

Parameters:

<Duration> **NORM**
Normal
EXT
Extended
*RST: NORM

Example: `CONF:DL:PHIC:DUR NORM`
Selects normal PHICH duration.

Manual operation: See "PHICH Duration" on page 75

CONFigure[:LTE]:DL:PHICh:MITM <State>

This command includes or excludes the use of the PHICH special setting for enhanced test models.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CONF:DL:PHIC:MITM ON`
Activates PHICH TDD m_i=1 (E-TM)

Manual operation: See "PHICH TDD m_i=1 (E-TM)" on page 75

CONFigure[:LTE]:DL:PHICh:NGParameter <Ng>

This command selects the method that determines the number of PHICH groups in a subframe.

Parameters:

<Ng> NG1_6 | NG1_2 | NG1 | NG2 | NGCUSTOM

Select NG_CUSTOM to customize N_g. You can then define the variable as you like with `CONFigure[:LTE]:DL:PHICh:NOGRoups`.

*RST: NG1_6

Example: `CONF:DL:PHIC:NGP NG1_6`

Sets N_g to 1/6. The number fo PHICH groups in the subframe depends on the number of resource blocks.

`CONF:DL:PHIC:NGP NG_CUSTOM`

Define a customized value for N_g.

`CONF:DL:PHIC:NOGR 5`

Directly sets the number of PHICH groups in the subframe to 5.

Manual operation: See "PHICH N_g" on page 75

CONFigure[:LTE]:DL:PHICh:NOGRoups <NofGroups>

This command sets the number of PHICH groups.

Parameters:

<NofGroups> <numeric value>

*RST: 0

Example: `CONF:DL:PHIC:NOGR 5`

Sets number of PHICH groups to 5.

Manual operation: See "PHICH Number of Groups" on page 76

CONFigure[:LTE]:DL:PHICh:POWer <Power>

This command defines the relative power of the PHICH.

Parameters:

<Power> <numeric value>

*RST: -3.01 dB
Default unit: DB

Example: `CONF:DL:PHIC:POW -1.3`

Sets the relative power to -1.3 dB.

Manual operation: See "PHICH Rel Power" on page 76

8.8 Analyzing Measurement Results

8.8.1 General Commands for Result Analysis

CONFigure[:LTE]:DL:CONS:LOCation....144
[SENSe][:LTE]:SUBFrame:SELect....144
UNIT:BSTR....144
UNIT:EVM....145

CONFigure[:LTE]:DL:CONS:LOCation <Location>

This command selects the data source of the constellation diagram for measurements on downlink signals.

Parameters:

<Location>

AMD
After the MIMO decoder

BMD
Before the MIMO decoder

*RST: BMD

Example: `CONF:DL:CONS:LOC AMD`
Use data from after the MIMO decoder.

Manual operation: See "Evaluation Range for the Constellation Diagram" on page 80

[SENSe][:LTE]:SUBFrame:SELect <Subframe>

This command selects the subframe to be analyzed.

Parameters:

<Subframe> ALL | <numeric value>

ALL
Select all subframes

0...39
Select a single subframe

*RST: ALL

Example: `SUBF:SEL ALL`
Select all subframes for analysis.

Manual operation: See "Subframe Selection" on page 78

UNIT:BSTR <Unit>

This command selects the way the bit stream is displayed.

Parameters:

<Unit> **SYMbols**
Displays the bit stream using symbols

BITs
Displays the bit stream using bits

*RST: SYMbols

Example: `UNIT:BSTR BIT`
Bit stream gets displayed using Bits.

Manual operation: See "Bit Stream Format" on page 79

UNIT:EVM <Unit>

This command selects the EVM unit.

Parameters:

<Unit> **DB**
EVM results returned in dB

PCT
EVM results returned in %

*RST: PCT

Example: `UNIT:EVM PCT`
EVM results to be returned in %.

Manual operation: See "EVM Unit" on page 79

8.8.2 Marker and Delta Marker

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8.8.2.1 Using Markers

CALCulate<n>:MARKer<m>:AOFF....145
CALCulate<n>:MARKer<m>:MAXimum[:PEAK]....146
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CALCulate<n>:MARKer<m>[:STATe]....146
CALCulate<n>:MARKer<m>:TRACe....146
CALCulate<n>:MARKer<m>:X....147
CALCulate<n>:MARKer<m>:Y?....147

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers and delta markers off.

Suffix:

<m> 1

Example: CALC:MARK:AOFF
Turns off all markers.

Usage: Event

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command positions a marker on the peak value of the trace.

Suffix:
<m> 1..n

Example: CALC:MARK2:MAX
Positions marker 2 on the trace peak.

Usage: Event

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command positions a marker on the minimum value of the trace.

Suffix:
<m> 1..n

Example: CALC:MARK:MIN
Positions marker 1 on the trace minimum.

Usage: Event

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off.

Suffix:
<m> 1

Parameters:
<State> ON | OFF
*RST: OFF

Example: CALC:MARK3 ON
Turns on marker 3.

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command positions the marker on a particular trace.

If necessary, the command turns on the marker first.

Suffix:
<m> 1

Parameters:

<Trace> 1 | 2 | 3

Number of the trace you want the marker positioned on.

CALCulate<n>:MARKer<m>:X <Position>

This command positions a marker on a particular coordinate on the x-axis.

If necessary, the command first turns on the marker.

Suffix:

<m> 1

Parameters:

<Position> Numeric value that defines the marker position on the x-axis.

Default unit: The unit depends on the result display.

Example: `CALC:MARK:X 1GHZ`

Moves the marker to the frequency of 1 GHz.

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Suffix:

<m> 1

Example: `INIT:CONT OFF`

Switches to single measurement mode.

`CALC:MARK2 ON`

Switches marker 2.

`INIT;*WAI`

Starts a measurement and waits for the end.

`CALC:MARK2:Y?`

Outputs the measured value of marker 2.

Usage: Query only

8.8.2.2 Using Delta Markers

CALCulate<n>:DELTamarker<m>:AOFF....148
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]....148
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CALCulate<n>:DELTamarker<m>[:STATe]....148

CALCulate<n>:DELTamarker<m>:TRACe....149
CALCulate<n>:DELTamarker<m>:X....149
CALCulate<n>:DELTamarker<m>:Y?....149

CALCulate<n>:DELTamarker<m>:AOFF

This command turns all delta markers off.

Suffix:
<m> 1

Example: `CALC:DELT:AOFF`
Turns off all delta markers.

Usage: Event

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command positions a marker on the peak value of the trace.

Suffix:
<m> 1..n

Example: `CALC:DELT2:MAX`
Positions delta marker 2 on the trace peak.

Usage: Event

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command positions a delta marker on the minimum value of the trace.

Suffix:
<m> 1..n

Example: `CALC:DELT2:MIN`
Positions delta marker 2 on the trace minimum.

Usage: Event

CALCulate<n>:DELTamarker<m>[:STATe] <State>

This command turns delta markers on and off.

Suffix:
<m> 1

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:DELT3 ON`
Turns on delta marker 3.

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

This command positions a delta marker on a particular trace.

Suffix:
<m> 1

Parameters:
<Trace> 1 | 2 | 3
Number of the trace you want the delta marker positioned on.

CALCulate<n>:DELTamarker<m>:X <Position>

This command positions a delta marker on a particular coordinate on the x-axis.

If necessary, the command first turns on the delta marker.

Suffix:
<m> 1

Parameters:
<Position> Numeric value that defines the delta marker position on the x-axis.
Default unit: The unit depends on the result display.

Example: `CALC:DELT2:X 1GHZ`
Positions delta marker 2 on the frequency of 1 GHz.

CALCulate<n>:DELTamarker<m>:Y?

This command queries the position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Suffix:
<m> 1

Example: `INIT:CONT OFF`
Switches to single measurement mode.
`CALC:DELT2 ON`
Turns on delta marker 2.
`INIT;*WAI`
Starts a measurement and waits for the end.
`CALC:MARK2:Y?`
Queries the measurement result at the position of delta marker 2.

Usage: Query only

8.8.3 Scaling the Vertical Diagram Axis

Programming example to scale the y-axis

```
//Start EVM vs Symbol result display in screen B.
CALC2:FEED 'EVM:EVSY'
//Refresh the measurement results based on the contents of the capture buffer
INIT:IMM
//Select screen B.
DISP:WIND2:SEL
//Select dB as the EVM unit.
UNIT:EVM DB
//Define the point of origin of 5 dB on the y-axis.
DISP:TRAC:Y:SCAL:FIXS:OFFS 5
//Define the distance of 10 dB between two grid lines on the y-axis.
DISP:TRAC:Y:SCAL:FIXS:PERD 10
```

DISPlay[:WINDow]:TRACe:Y:SCALe:AUTO.....150
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DISPlay[:WINDow]:TRACe:Y:SCALe:AUTO

This command automatically adjusts the scale of the y-axis to the current measurement results.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

Example: `DISP:TRAC:Y:SCAL:AUTO`
Scales the y-axis of the selected result display.

Usage: Event

Manual operation: See "Y-Axis Scale" on page 81

DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:OFFSet <Origin>

This command defines the point of origin of the y-axis and thus has an effect on the scale of the y-axis.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

Parameters:

<Origin> Point of origin of the y-axis.
The unit depends on the result display you want to scale.

Example: See chapter 8.8, "Analyzing Measurement Results", on page 144.

Manual operation: See "Y-Axis Scale" on page 81

DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:PERDiv <Distance>

This command defines the distance between two grid lines on the y-axis and thus has an effect on the scale of the y-axis.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

Parameters:

<Distance> The unit depends on the result display you want to scale.

Example: See chapter 8.8, "Analyzing Measurement Results", on page 144.

Manual operation: See "Y-Axis Scale" on page 81

8.9 Configuring the Software

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CONFigure:PRESet

Initiates a preset to the default state of the software, and, if connected to an analyzer, also presets the analyzer.

Example: `CONF:PRES`
Presets the software.

Usage: Event

DISPlay[:WINDow<n>]:SELect

This command selects the measurement window.

Example: `DISP:WIND2:SEL`
Selects screen B.

Usage: Event

FORMat[:DATA] [<Format>]

This command specifies the data format for the data transmission between the LTE measurement application and the remote client. Supported formats are ASCII or REAL32.

Parameters:

<Format> ASCii | REAL

*RST: ASCii

Example: `FORM REAL`
The software will send binary data in Real32 data format.

MMEMory:LOAD:DEModsetting <Path>

This command restores previously saved demodulation settings.

The file must be of type "*.allocation" and depends on the link direction that was currently selected when the file was saved. You can load only files with correct link directions.

Setting parameters:
<Path> String containing the path and name of the file.

Example: `MMEM:LOAD:DEM 'D:\USER\Settingsfile.allocation'`

Usage: Setting only

MMEMory:LOAD:TMOD:DL <TestModel>

This command loads an EUTRA test model (E-TM).

The test models are in accordance with 3GPP TS 36.141.

Setting parameters:
<TestModel>
'E-TM1_1__10MHz'
EUTRA Test Model 1.1 (E-TM1.1)
'E-TM1_2__10MHz'
EUTRA Test Model 1.2 (E-TM1.2)
'E-TM2__10MHz'
EUTRA Test Model 2 (E-TM2)
'E-TM3_1__10MHz'
EUTRA Test Model 3.1 (E-TM3.1)
'E-TM3_2__10MHz'
EUTRA Test Model 3.2 (E-TM3.2)
'E-TM3_3__10MHz'
EUTRA Test Model 3.3 (E-TM3.3)

Example: `MMEM:LOAD:TMOD:DL 'E-TM2__10MHz'`
Selects test model 2 for a 10 MHz bandwidth.

Usage: Setting only

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